UNITED STATES DEPARTMENT OF AGRICULTURE

FOREST SERVICE

FOREST RESEARCH ACTIVITIES

FOREST MANAGEMENT
RANGE MANAGEMENT
FOREST PRODUCTS

FOREST ECONOMICS
FOREST SURVEY
FOREST INFLUENCES

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FOREST RESEARCH

BI-MONTHLY REPORT

February 1, 1941

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GENERAL

Allegheny

Branch Stations. During the past several months an effort has been made to complete the improvement program at the headquarters plant of the Beltsville Station. The laboratory and staff quarters are now essentially ready for occupancy and use. The headquarters building group includes two residences, a large staff quarters building with combined dormitory, kitchen, and dining facilities, an office-laboratory structure, a garage-workshop, an exhibit shop-office-warehouse sponsored by the Washington Office Division of Information and Education, and other minor utility structures. Landscaping of the grounds is scheduled for completion early next spring.

Because of the lack of available WPA labor at Beltsville, the project there was transferred to the Eastern Shore. A 16-man crew is now working on the latter Experimental Forest, constructing protection and utilization roads on one-quarter of the Forest where about 100 acres of 4-year-old plantation present an extremely high hazard. Assistant Agricultural Aid R. P. Broomall was transferred from Beltsville to supervise the work of this crew.

Cooperation. An illustrated talk on "Forest management principles based on studies of virgin northern hardwood-hemlock forests" was given by Hough before a joint meeting of the Ecological Society of America and the Society of American Foresters at the meeting of the A. A. A. S. in Philadelphia.

Staff Meetings. This year monthly staff meetings, each lasting a whole day, are being held. Half of the time is devoted to a talk by an individual of a cooperating agency. At the meeting in early December, Assistant State Forester E. B. Moore described the aid given by the State of New Jersey to private forest owners; at the meeting in late January, Assistant Regional Forester G. H. Lentz discussed federal participation on forest lands in state or private ownership. At the latter meeting there was also a general discussion of Flood Control work. Sessions on Economics and Forest Management will be held at later meetings.

California

As carried in news releases and notices in various scientific organs, Director E. I. Kotok transferred in January to Washington, to take over the duties of Assistant Chief in charge of the Division of State and Private Forestry.

Cary L. Hill retired on January 1. In charge of the Division of Forest Products since its transfer to the Station in 1927, and of the Office of Products in the Regional Office before that time, Mr. Hill has been in the Service continuously since his graduation from the University of Michigan in 1905, except for 3 years on the faculty of that institution.

Central States

Farm Forestry. On December 12 Dr. E. R. Martell of the Purdue University Forest School presided at a meeting called to take stock of the progress made during the past year in Cooperative Farm Forestry in Indiana. Representatives of the School, Agricultural Experiment Station, Extension Service, Soil Conservation Service, and Central States Forest Experiment Station, were present. Reports on the South Bend and on the Madison-Ripley County Demonstration Projects stimulated lively discussion. The problems of growth have appeared immediately, with the Project Supervisors recognizing the need of research in advance of demonstration. They desire help in making growth determinations.

On January 15 farm foresters in charge of the demonstration projects met at Dayton, Ohio, to discuss their problems. Arrangements were made for this Station to cooperate with the S.C.S. and the demonstrations in obtaining data on the approximate growth rates on these project areas.

Demonstration Projects have been established in S.C.S. Region 3 as follows:

Michigan	1 project	Oak-hickory
Indiana	2 projects	1 oak-hickory & beech-maple
		1 upland swamp forest (beech--red gum--pin oak)
Ohio	1 project	beech-maple & oak-hickory
Tennessee	1 project	oak-hickory

Most of these include only three or four major soil types.

Ohio Woodland Survey. On January 4, the County and District Supervisors of the Ohio Woodland Survey met in Columbus for their regular meeting. Members of the Station attended the morning and afternoon sessions.

County Agricultural Planning. As scheduled, representatives of the Station joined with other agencies and took part in the 1-day discussion or "school", followed by three days of field demonstration with the Township Committeemen of the A.A.A. in Ross County, Ohio.

One outstanding point driven home by this experience was the unpredictable and infinitely varying condition of unmanaged, repeatedly cut, and haphazard woodlands in Ross County, Ohio. The greatest need of tree growth on one acre may be release from grape vines; another will need sanitation cutting of diseased individuals; another will need release of valuable species; another, removal of tops from logging; another removal of dead chestnut; another clean cutting and a new start of sprouts. Some arres need protection only. Frequently, all of the foregoing conditions occur in a single small woodland. The owner seems quite blind to these several steps in improving the woods. Ross County woodlands are no different from those in other counties in the great variety of conditions.

The meeting and demonstrations were considered a decided success. In addition, they were attended by members of adjacent Jackson County's Planning Committee and County Agent, who are just getting under way in county agricultural planning.

Meetings. Auten attended the Soil Science Society of America meeting December 4, 5 and 6 at the Drake Hotel in Chicago. He presented a paper, "A Critical Discussion of the Classification of Soils for Forests."

WPA. Since the inception of the W.P.A. project on August 5, 1940 $6,200.05 in Federal money has been expended. The project is estimated to be 43.3 percent complete.

Work during the past two months has been devoted chiefly to the following items:

(1) Volume tables. Local and general volume tables were calculated from individual tree data for various species and localities.

(2) Stand studies. These were chiefly the summarization of data gathered in the Sylamore Experimental Forest.

(3) Flood Control. Much of the work consists in map making and tracing. In addition, data on land use and

soil, slope and erosion of land was compiled from aerial photo maps of the Cumberland River Valley by use of planimeters.

(4) Financial aspects of private forestry. This work consisted in the summarization of data on number of trees, basal area, cubic foot volume, and net board feet in representative stands of Ohio farm timber.

(5) Forest Management. Drafting figures for manuscripts being prepared for publication.

Lake States

C. W. Thornthwaite, meteorologist for the Soil Conservation Service, who is temporarily detailed to the Weather Bureau as Acting Assistant Chief, visited the Station to discuss how the collection of weather data can be more closely related to the growth and development of plant life.

On December 3, Mr. Zon gave a talk on "New Goals for Old in Forestry" before the Gown in Town Club.

Northeastern

The Northeastern Forest Experiment Station Research Council met at the station December 10 - 11 and had a lively discussion as to possibilities for reorientation of the station's Forest Management program. Previous discussion of problem analyses with members of the Regional Office and various interested agencies formed a background for the discussion.

Ten members of the forest management staff met early in February for the first of a series of bi-monthly meetings to discuss their work. The physiological and cytological aspects of forest genetics were explained by Snow and Duffield respectively.

Several members of the Forest Genetics staff are taking advantage of seminars being held at Yale and 5 members of the management staff reviewed statistical methods in a short series of lectures delivered at the Connecticut Agricultural Experiment Station.

Library and Files. Following a visit of Librarian Mildred Williams of the Washington office, a scheme for more satisfactory handling of our small library has been put into effect. This resulted in a great reduction in time needed for card indexing and

cleared the shelves of a large amount of miscellaneous unnecessary material.

Southern

Sample plot corner posts. The following memorandum by Liefeld furnishes interesting information on metal corner posts:

"Experiment O-65, in Compartments A-1 and A-2 of the Olustee Experimental Forest, was established in the summer of 1933 to study the effect of different frequencies and intensities of controlled burns on the survival and development of longleaf pine seedlings. The experimental design is a 5 x 5 Latin square, and at the time of establishment 36 metal angle-iron fence posts were "planted" to mark all of the plot corners.

"Examination on January 20, 1941 disclosed that 5 of the 36 posts had rusted so badly at the ground line that only slight pressure had to be exerted to break the posts off. It is estimated that about half of the posts will need replacement within a few more years.

"From the standpoint of price and durability it seems to me that metal posts of this type are no better than fat pine or heart cypress and probably quite inferior to treated wooden posts."

Southwestern

Personnel. Effective December 1, Kenneth A. Brinkman, Junior Forester, was transferred from the Southern Forest Experiment Station, where he had been engaged on flood surveys, to the Southwestern Station and assigned to forest influences investigations at the Parker Creek Branch Station.

FOREST ECONOMICS

FOREST SURVEY

Appalachian

Inventory: Line plot work on the inventory phase of the Survey in Virginia, started early in March, was completed the fourteenth of December. A total of 4,000 miles of line was run and data were recorded for more than 18,000 forest plots. Crews averaged 2.8 miles per day as compared to 2.7 in the Survey of North Carolina and 3.3 in South Carolina.

Tabulation of the Virginia field data is proceeding on schedule and the basic tables of area and volume should be available for the Coastal Plain and Piedmont units within two months. Numerous requests have been received from pulpmill operators, lumbermen, and public agencies for Survey findings in Virginia, particularly for information regarding the timber resources in the Coastal Plain. Advance information on this important forest region will be released as soon as data are available.

Drain: Cooperation with the Bureau of the Census to determine 1940 lumber production in South Carolina, North Carolina, and Virginia is in full swing. Census forms have been mailed to operators in South Carolina and North Carolina and the completed forms are being received at this Station for editing and checking. Three field men are making a mill-to-mill canvass of the wood-using industries of Virginia, obtaining Census figures and supplemental information for the Survey at the same time. Preliminary indications are that an unusually large number of mills are in operation in these states and that the 1940 cut was the largest in the past decade.

A special study of fuelwood consumption in Virginia is being made. This item of drain is a very important one in the eastern states, but accurate information regarding the volume, species, and size of tree used is difficult to obtain. By detailing one man to sample rural and urban wooduse throughout Virginia, we hope to obtain much more reliable information on this subject than has been available in other states in our territory.

Reports: The last of four reports for North Carolina Survey units has been completed and will be issued as Release No. 7, "Forest Resources of the Mountain Region of North Carolina."

Lake States

Forest ownership figures recently compiled for the states of Minnesota, Wisconsin, and Michigan compared with those prepared for the Copeland Report illustrate graphically the trend from private to public control. Federal ownership has more than doubled in 10 years and State and County ownership has increased nearly fourfold. The acreage in farm woods has remained fairly constant. The new public acquisitions have come primarily from the private holdings outside of farms.

Ownership	Percentage	
	1930	1940
Federal.....	5.3	12.6
State and County.....	6.9	26.7
Farmer.....	25.5	27.2
Other private.....	62.3	33.5
Total.....	100.0	100.0

Northeastern

Before its interruption, the forest survey being made with CCC crews in the white pine region of southwestern Maine covered practically two million acres at an intensity of 1/4% for inventory and 1/2% for type-mapping purposes.

Of this area 22.2% is in active farm, 1.2% in idle or abandoned farm, 2.1% in roads, villages, etc., 9.0% is non-productive, (5.7% is water), and 65.5% is in forest. Of the forest area, only 3.0% is old growth, 4.2% is reproduction, 2.6% was recently clear cut, and 0.1% was planted. The remaining 90.1% is second-growth, 57.8% uncut and 32.3% from which some material has been removed.

Twenty-eight of the S.A.F. types were represented, 21 northern forest types, 6 central forest types, and one southern forest type, this latter being No. 90 (southern white cedar), of which several stands exceeding 10 acres each were found. The aspen-pin cherry types comprise 15.6%, northern hardwoods 10.9%, red oak 6.9%, hemlock 8.1%, pitch pine-oak 3.0%, spruce-fir 9.7%, and white pine 40.9% of the forest area, the remaining 9.9% being distributed among a number of minor types.

Northern Rocky Mountain

During the holiday seasen, Winters talked before the forestry section of the Pacific Northwest Scientific Association on the subject "The Role of the Timber Resource in National Defense."

Inventory. A new method is being used in inventorying Fergus County in eastern Montana. In this work, three WPA workers together with two technical supervisors and field men compiled basic land use maps from aerial photographs made in connection with the AAA program. From these photographs and township base plats the boundary between forest land and open grazing or agricultural lands could readily be determined and traced on a vellum overlay. Inasmuch as a very large proportion of the land area in Fergus County is open grazing land, the use of aerial photographs greatly reduced the amount of field travel necessary to prepare a satisfactory forest type map. Field work was undertaken during the periods of favorable weather conditions. This system is proving to be very satisfactory for eastern Montana area where aerial photographs are available. Since the total area in Fergus County is 2,766 M acres (5 percent being forest land), the near completion of this work in a little over two months indicates that the system is relatively inexpensive.

Compilation of field data for Flathead County, which contains much inaccessible alpine country including Glacier National Park, is completed. Only 11 percent of the land area in the county is nonforest. Of the forest area only 55 percent is now, or can be, considered as potentially accessible. The remainder is relatively inaccessible high country, part of which is included in the recently designated Bob Marshall Wilderness Area.

Reports. The Forest Survey report for northern Idaho has been edited and submitted to the Washington Office for review. A 25-page condensed report for immediate distribution has been prepared and will be mimeographed within the next few months. In the longer version, considerable space is devoted to the costs of timber growing. One thing which stands out is that it will probably cost more to protect and administer the national forest land than will be received in terms of direct revenues. However, the very expensive blister rust control program has been justified on the basis that the net deficit will be lower with blister rust control than without it.

Pacific Northwest

General. The defense program is beginning to affect survey work; an increase in requests by small operators and individuals for information on timber stands is apparent. Maps, particularly the detailed county type maps, are in demand. Sales of State type maps during the year totalled about 150 copies, making a cumulative total of approximately 1,900 copies sold since the maps were published. In addition, more than 4,000 copies have been distributed to date without charge to public agencies and other cooperators.

Survey staff members have been cooperating with Flood Control surveys in bringing up to date forest inventory data on the Walla Walla watershed. Briegleb is directing the preparation of growth estimates and other data needed for preparation of a forest management plan. Moravets prepared a generalized type map of the Pacific Northwest on a small scale for the Northwest Regional Council for Education, Planning, and Public Administration.

Douglas-Fir Region

Keeping Findings Current. Compilation of forest type and timber volume information has been completed for Lewis and Wahkiakum Counties, Washington, and material is now being assembled for preparation of the revised county reports. Compilation of type areas for Benton, Polk, Mason, Kitsap, and Jefferson Counties has been completed. Revised type maps have been prepared for Benton and Polk Counties.

Extracts From Findings. Lewis, a county of $1\frac{1}{2}$ million acres, is the scene of the most extensive cutting in western Washington. Annual sawlog drain is nearly twice that of any other county. Examination of cut-over lands indicates that restocking is better than most other counties recently revised. Approximately half the cut-over area classified as nonrestocked in 1933 had restocked by 1940 and more than two-thirds of the area cut over between 1920-29 had restocked by 1940. Cutting is progressing in this county at a rate better than 10,000 acres per year.

Wahkiakum County shows some interesting changes in timber volume. Although old-growth volume has been depleted severely by cutting, increase in second-growth volume has been large. Many of the young hemlock stands are now at an age where they are making highest increase in board-foot volume.

Ponderosa Pine Region.

Consideration of new trends in depletion resulted in a decision to revise estimates of future depletion for the first decade upward.

It seemed appropriate to do this while the regional report was being revised. This also involved changes in periodic growth and timber supply calculations. Briegleb completed this job and the report has been revised accordingly. Corrected portions are now being typed and the report will be sent back to Washington soon.

Southern

General. Most of Eldredge's time was put in taking part in meetings of the Society of American Foresters, at Washington, D.C., the National Resources Board Regional Planning Advisory Committee, South Central Region, the subcommittee of the Southern Great Plains held at Dallas, Tex., the Southern Pulpwood Conservation Association held at Atlanta, Ga., Tulane University students, New Orleans, La., and the New Orleans Academy of Sciences.

Interpretive Section

Ineson continued work on naval stores analyses and on the financial structure of the wood-using industries study, study of the distribution of important timber species in southern territory, using Survey line-plot data, and preparation of estimates of forest area by county, and volume per average acre by county.

Mensurational Section

Cooperative work for the Appalachian Station and a small amount of work for the Commodity Exchange Administration entirely occupied the time of punching and tabulating subsection.

Work was continued on naval stores tables for the 1938-39 season and started for the 1939-40 season, the financial structure of the wood-using industries, and on estimates of forest by county volume per acre by county for Southern territory.

Growth estimates for 1938 were completed for Texas Units Nos. 1 and 2, and Louisiana Units Nos. 2 and 5, Georgia Units Nos. 1-4, Florida Units Nos. 1-4, and Mississippi Unit No. 1.

Necessary time was given to conduct of the cooperative project with the Census in which forms on 1940 lumber production, lumber distribution, and stumpage and log prices for Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Oklahoma, and Texas are being edited. Davis, Smith, Buchanan, and Stewart are on the project, with Stover rendering assistance as needed.

The East Texas Post Oak Belt. Forests cover 38 percent of the area, or 4,401,100 acres, but much of this is fenced and used as range for livestock. Cropland occupies 26 percent, or 3,000,800 acres. Other agricultural land (principally pasture cleared of forest growth) occupies 29 percent, or 3,393,500 acres. Other areas including brush and mesquite, towns, rights-of-way, etc., occupy the remaining 7 percent of the area, or 866,300 acres. Currently, little change is taking place in the proportion of forest area.

Scrub hardwoods occur on 93 percent of the forest area, with post oak predominating and with blackjack oak and hickory as common associates. Elm and hackberry occur along the borders of the prairies, and live oak is common in the southern portion. The trees are boled and limby, averaging 40 to 50 feet in height at maturity. As a result of grazing, fire, and continued cutting of the best trees while leaving the pocrest, many of the forest stands have become poorly stocked or deteriorated in quality.

The forests of the post oak belt do not compare with the commercial forests of the South in the production of lumber or other high-priced commodities, but they are of great importance locally. They provide annually several million dollars' worth of forest products such as fuel wood, fence posts, farm construction materials, and lumber. Much of this material is produced by farmers for their own use; but some is cut and sold to provide additional income. Over and above these benefits the forests of the post oak belt serve as a natural cover to prevent both wind and water erosion in an area where soils without adequate vegetative cover erode severely and deteriorate quickly.

FOREST TAXATION AND INSURANCE

Pacific Northwest

Taxation. Some progress has been made on the Washington local government adaptation study. Receipts by sources and expenditures by principal functions were obtained by a study of the financial reports of five selected counties.

Tax rates in each forest land county of Oregon and Washington were tested for correlation with percent of forest area depleted by cutting and with percent of timber volume in public ownership as computed from Forest Survey reports. While no significant correlation was observed in the Washington data, there was a very significant correlation in the Oregon data. High tax rates were definitely associated with a high degree of forest depletion

and low tax rates were definitely associated with a high proportion of public ownership of timber. The interpretation to be placed upon this correlation study is now being considered. It may be reasonable to assume the sum of other factors is more important in causing high tax rates than a reduced or restricted tax base.

The second annual meeting of the Oregon Taxpayers' Federation was attended by DeVries, who has been appointed chairman of a committee of the Legislative Council of the Portland Chamber of Commerce to study and report on a number of taxation bills pending in the legislature.

Southern

Field work in Craig's tax-index study was completed in Coosa and Barbour Counties, Alabama, in December and was begun in Choctaw County late in January. With completion early in February of the latter county and Jackson County, initial field work in Alabama will be finished.

Plans are being made for cooperation with the Regional office on the first resurvey in Mississippi, to obtain tax data for 1941 to bring up-to-date the information obtained in this State on taxes of 1936-1939.

Following issuance in March of the Alabama report as an Occasional Paper under the title, "Taxes on forest property in nine selected counties in Alabama, 1937-1940, with State averages." Craig will extend this study to Louisiana.

NEW PUBLIC DOMAIN

Northeastern

Under the acquisition program under way during the past year, carried on by the Station with the supervision of the Regional Office, over 1,000 acres were optioned on the Massabesic Purchase Unit. With the purchase of these tracts the Massabesic Experimental Forest will contain approximately 3700 acres of land. The new additions round out present holdings and add considerable productive white pine land to the Forest.

Pacific Northwest

Work on the New Public Domain report consisted of reviews of outline and parts written and proposed organization for a series of progress reports. In addition, considerable attention was given to the devising of a measure to broaden Oregon State Board of Forestry powers in acquiring lands for State forest purposes in cooperation with the Governor's Economic Council, Portland Chamber of Commerce, and State Forester. The proposed new powers include acquisition by purchase and donation and authority to issue revenue bonds for purchase of lands.

Land Planning. The manuscript by M. L. Upchurch of the Bureau of Agricultural Economics, "Institutional Factors of Land Use Adjustments in Coos County, Oregon", was reviewed. The manuscript has some 180 pages and contains three sections, forestry, grazing, and local government. It is pointed toward grazing as an alternative use for deforested lands and a means of keeping deforested lands on the tax roll or of restoring them to the tax roll.

PRIVATE FORESTRY

California

Much of the economics work in the past two months has been cooperative with the Forest Survey and the Regional Office in assembling data and preparing statements for the nation-wide forest program. Two statements have been prepared, one on the Forest Problems of California and the other on Application of the Forest Program to Problems of the Sierra Nevada Foothills.

The crux of the State's forest problem was found to lie with the privately-owned forest lands, which include 5.5 million acres of pine timberland, 1.4 million acres of redwood, and 18 million acres of water-yielding protection forest. There are 70 billion board feet of timber on private forest lands in the pine region; the acreage ratio of virgin timber to second growth is about fifty-fifty; and these private lands carry a total assessed valuation of nearly 40 million dollars. In the redwoods, comparable figures are 54 billion feet of timber; twice as much virgin acreage as second growth; and a valuation on the lands practically as much as on the pine. Most of these areas occur in the relatively large holdings of lumber and railroad companies. The largest owner of pine timber controls 850,000 acres,and a majority of the main industrial owners have over 10,000 acres. In the redwood, ownerships are smaller, but here again more than 10,000 acres is quite common.

The redwood region of course is unique, carrying the heaviest stands of timber in the world: 450,000 board feet per acre on a 40-acre tract; 1,000,000 board feet on a single acre.

The main trouble with forest industry in both the pine and redwood regions is over-investment in timber and mill with resulting pressure to liquidate. This over-investment means excessive sawmill capacity and manufacturing ability for greater than growth possibilities on tributary forest lands. Destructive logging methods still bring in over one-fourth of the redwood harvest each year. One and a quarter million acres of private forest land are restocking poorly or not at all in California.

Two of the tables which were included in the statements, one showing ownership of both commercial and noncommercial forest land, and the other showing status of forest practice on privately-owned lands, are given below:

The ownership of forest lands in California

Ownership class	Total	Commercial[1]	Noncommercial[1]
	Thousand acres	Thousand acres	Thousand acres
Private			
Industrial and other	19,073	6,473	12,600
Farm woodland	5,426	326	5,100
	24,499	6,799	17,700
Public			
State, county, and municipal	649	45	604
National forests	15,986	6,696	9,290
Indian reservations	527	115	412
Other Federal	6,498	--	6,498
	23,660	6,856	16,804
All classes	48,159	13,655	34,504

[1] According to standard Forest Service definition

Status of forest practice on privately-owned commercial forest lands (industrial) in California

Management class	Pine region		Redwood region	
	Area in thousand acres	Percent	Area in thousand acres	Percent
Total area	5,135	100	1,338	100
Intensive sustained-yield management	0	-	0	-
Extensive sustained-yield management	313	6	0	-
Extensive management, not sustained yield	2,389	47	592	44
Total under management	2,702	53	592	44
Additional lands partially productive, with some fire protection but without assurance of future management	2,433	47	746	56

Central States

The 10 stand tables originally prepared for the Ohio Study are to be shown on a 12-foot as well as an 8-foot sawlog length basis.

The 12-foot sawlog requirement for sawlog trees was standard in the Illinois procedure. Sound culls (trees with less than 12 feet of sawlog length) were prominent in Illinois, but were of minor importance in Ohio. The outline of procedure for getting Ohio Woodlands on the 12-foot basis will permit direct comparison of data from the two general localities.

Plans for using the Illinois pasture, building, farm equipment, and livestock inventory data in statements comparable to the "forest statement" were under way during December and January. A 6-week detail in Washington for this purpose, beginning at the completion of the forest statement text, is contemplated for Worthington. The commencing date for the detail is about March 1.

Lake States

Minnesota Cooperative Farm Forestry. A bulletin, "Home Grown Material for Farm Construction in Southeastern Minnesota," to be published by the University of Minnesota Agricultural Extension Service, has been prepared by C. H. White (Norris-Doxey research man employed by the Lake States Forest Experiment Station and the Minnesota Agricultural Experiment Station).

This report is based on a recent survey of farm buildings made in Winona County, Minnesota, and brought to light a number of examples of successful use of local hardwood lumber that might be profitably adopted by other woodland owners. One outstanding example was an attractive modern home completely built for a cash outlay of only $862.70. This cost represents a charge for all materials and equipment used but does not include labor. Self help and ingenuity built the home, with a productive woodland supplying 97 percent of the lumber used.

Northeastern

Farm Forestry - Connecticut. Money for the installation of equipment for stoking hogged wood at a Connecticut State Institution has not been forthcoming. Further work on this phase of the project has been suspended until the financial difficulties can be overcome.

Tests were completed in December and January of the hogging of cordwood in 4, 8 and 12 foot lengths. The results indicate that a dollar a cord is the approximate cost for the processing, but savings can be expected with better equipment more efficiently placed.

All field work on the fuel wood production time studies has been completed with the exception of further work necessary on the logging arch, frames and sled for handling bundles of cordwood and a small amount of work with the power drag saw. All of this work should be completed by March 1.

Good progress continues to be made on the portable charcoal kilns. A report will be prepared soon and definite recommendations for the use of the kiln developed will be made.

Reports now in progress cover the hogging studies and fuelwood production time studies.

Southern

Farm Woodland Studies. Bond has completed the Station's portion of a BAE bulletin entitled, "Farm Adjustment in Washington Parish, Louisiana." The Station's contribution, a chapter entitled, "The Possibility of Farm Forestry as a Farm Enterprise," is based on an analysis of a timber inventory, growth study, and canvass of farm uses and sales of timber products from 66 sample farms in that Parish.

The study showed that about 40 percent of the farms of the Parish had a total area of less than 40 acres and about 60 percent less than 60 acres. Of the total area, crops occupied about 50 percent, woodlands about 40 percent, and open pastures, waste land, and farm buildings the remaining 10 percent. Approximately 10 cords of fuelwood and 60 fence posts, obtained largely from the farm woodland, were used annually on the farm. Annual sales of logs, ties, pulpwood, and fuelwood averaged only $4.00 per farm.

The common practice of cutting fuelwood from the best pines and hardwoods has seriously depleted the growing stock, so that the average woodland contains less than 1 M board feet of sawtimber per acre. In spite of mistreatment and uncontrolled fire, however, the farm woodland has restocked to a fair stand of young pine which, with rapid growth and excellent market outlets, holds promise of good yields and substantial incomes if properly managed. Good management requires the following practices:

(1) Control forest fires

(2) Improve stands by cutting fuelwood from defective and poorly formed trees and from species of little commercial value.

(3) Build up the sawtimber growing stock by limiting the cut during each five-year period to only 20 percent of the sawtimber volume.

(4) Select and mark merchantable trees to be cut so as to build up the quality of the growing stock.

(5) Limit grazing to a few work animals so that reproduction occurs naturally.

With good management of the average 25-acre woodland, the farmer during the next 5 years can produce and sell only a limited volume of sawlogs worth about $50.00 besides supplying the annual fuelwood and fence post requirements, which if purchased would cost about $50.00 annually, or $250.00 during the five-year period.

After 30 years of periodic cutting and management it is estimated that the growing stock will be built up gradually to a little over 3,000 feet and the periodic income from sale of forest products increased from $50.00 to $160.00, besides supplying home needs. On an annual per-acre basis this is an increase from $ .40 to $1.28.

Some of the farm woodlands of the Parish have been protected from fire and cut conservatively. The best 10 percent of the woodlands sampled now have stands of slightly over 3 M feet per acre, or a volume equivalent to that expected on the average farm woodland after 30 years of management. If 25 acres of these better stocked stands were placed under good management for 10 five-year periods it is estimated that the periodic income from sale of forest products could be gradually increased from $160.00 to $345.00, or from $1.28 to $2.76 per acre per year. Such an income would substantially supplement the present low cash income from all other farm enterprises, approximating $250.00 annually.

During a 12-month period a farmer has 146 days, half of which occur during the winter months, unemployed for any farm enterprise. This is more than enough to cut and manage 200 acres of farm woodlands as contrasted with the usual 25 acres. With 200 acres of woodland, averaging about 3,000 feet of sawtimber per acre, he could cut and sell annually the following forest products:

38,800 board feet of logs (felled and bucked)	$270.00
16 units of pulpwood (stacked)	24.00
120 ties (felled and hacked)	36.00
Total	$330.00

In addition he could cut and use annually 20 cords of fuelwood and 100 fence posts, which if purchased would cost him about $90.00. Such a woodland would yield a larger cash income than is now received from crops, livestock, and other miscellaneous farm products. Furthermore, no additional outlay or expense for labor and equipment not now available from his farming operations would be involved. The only additional expenses over those of the present farm woodland would be taxes on about 70 acres, which are in excess of the 160-acre homestead now exempt from taxes under Louisiana statutes, and interest on the investment in the woodland. Taxes would cost 10 to 20 cents per acre and timber land would have a value of $10.00 to $20.00 per acre, depending on location and volume and quality of timber.

There are approximately 200,000 acres of nonfarm land in the Parish, much of which could probably be purchased at a reasonable price. But the farmer does not have cash or credit with which to purchase. Furthermore, technical services to assist him in forest management are limited. While this expansion of the size of the

farm woodland appears as a promising farm adjustment in Washington Parish, there are many problems to be solved before it can be effectuated.

Selective Cutting. In connection with the cutting cycle study in second-growth stands now in progress on the Crossett Experimental Forest, Reynolds reports that two of the eight 40-acre compartments being handled on a 3-year cycle were cut for the second time during the year. A 100 percent inventory of these was made prior to the marking in order to determine the amount of growth the stands had made during the 3-year period following the first cut. In 1937 after the first cut the compartments averaged approximately 3,400 board feet of merchantable sawtimber 12-inches d.b.h. and larger per acre. The growth per acre per year over the three-year period amounted to 332 board feet and the increase in volume amounted to 9.8 percent simple interest or 6.2 percent compound interest. At $8 per thousand board feet the gross value of the growth per acre per year amounted to $2.66. With yearly expenses amounting to $.25 per acre the net value of the growth would be equal to $2.41.

FOREST MANAGEMENT RESEARCH

FOREST FIRE PROTECTION

California

Project work in the Fire Division has been relatively static during the winter months while members of the staff have participated in the preparation of a problem analysis of fire protection in California.

The problem analysis consists of (1) a condensed summary of fire-protection needs, (2) a review of the major problems confronting the fire-control agencies, with discussion of the manner in which different parts influence forest protection, (3) evaluation of the relative importances of the problems to fire-control development, (4) consideration of the susceptibility of different parts of the problems to research attack, and (5) development of a long-term research program. The analysis adds considerable emphasis to the need for continued research in fire behavior and for immediate attack in the field of fire effects. Present personnel cannot handle the latter without abandoning other high-priority studies.

The Region 5 fire-danger-rating system is being thoroughly revised this winter to make it better fit the needs of fire-control administration. The new system will employ average afternoon wind velocity (temporarily by averaging noon and 4:30 p.m. observations), and will integrate condition of the annual vegetation into the rate-

of-spread index. Rate of forward spread is to be substituted for rate of perimeter spread, in use at present. Presuppression strength, with the exception of detection, will be governed by additional indexes derived from integration of spread and other variables. The Experiment Station has participated in numerous conferences with the Regional Office fire-control staff and has revised the spread index on the basis of most recent experimental data.

Lake States

R-9 Protection Analysis. In December Mitchell completed the draft of the Region 9 fire protection analysis and sent copies to the Regional Office and the Central States Station for review. On January 7 a conference was held in Milwaukee, attended by representatives of the Central and Lake States Stations and the Regional Office, at which it was discussed in detail. The final report was completed and forwarded to the Washington Office on January 24.

Mitchell also attended the annual conference of Lake States fire protection chiefs in Milwaukee on January 21-23, at which he presented the case of fire research and stressed the need of closer cooperation between State and Federal agencies working in this field. As a result, a motion was passed to appoint a committee to bring this about and Mitchell was asked to round up the information necessary as a basis for committee action. Steps to this end are being taken.

On January 20 Karl Moessner of the Superior was detailed to the Station for a period of two months to assist in the compilation of the 1940 fire-weather statistics and to help on fire studies.

Northern Rocky Mountain

Five years of study of the altitudinal distribution of fire danger on the Priest River Experimental Forest established definitely that in the Priest River Valley at night fire danger rated safest on the valley bottom and low elevation slopes, most dangerous in a "thermal belt" at midaltitudes, and decreased with elevation above the belt. The study showed furthermore that the low danger in the valley was due to nocturnal temperature inversions.

In 1940 these principles were tested in the Salmon River Canyon of Idaho, on the slopes of Desert Mountain near Belton, Montana, and in Rock Creek Canyon near Red Lodge, Montana. On Desert Mountain a Priest River type of altitudinal fire danger distribution was found but in both the Salmon River and Rock Creek

Canyons temperature inversions amounted to only a few degrees and the fire danger at night was found to be practically the same near the valley bottom as in the poorly defined thermal belt. Above the thermal belt danger ratings decreased with elevation at the usual rate.

Here were two kinds of nocturnal altitudinal fire danger distributions. In one case midaltitudes were the most dangerous and the low elevations safest, and in the other case low elevations rated as dangerous as midelevations. A search was therefore made to discover why they differed. Cox's 1/ discussion of the factors which influence temperature inversions contained the answers. The major reason for the difference appeared to be the type of topography.

The Priest River Experimental Forest and Desert Mountain areas have typically broad valleys surrounded by mountains, which have relatively small summit areas. In this type of topography, according to Cox, most of the air-cooling at night takes place at low or moderate elevations and the cold air finds its way slowly into the low lying areas and inversions of large magnitude accrue. The Salmon River and Rock Creek Canyons are in a plateau type of topography which has a large summit, or near summit, area. In such areas, according to Cox, much air is cooled at night at high elevations, the pressure of the cold air on the plateaus causes katabatic winds in the canyons. The falling air is warmed adiabatically and also interferes mechanically with cold air accumulation in the canyons. Therefore, large inversions cannot occur, and the warm winds tend to make burning conditions relatively bad at low elevations.

The basic physical processes which cause nocturnal inversions are everywhere operative during clear weather. Therefore, there should be a tendency in all mountainous regions for low areas to be relatively safe, and a thermal belt above relatively dangerous at night. There may be, however, some factors or conditions which interfere with inversion formation. Cox discusses large numbers of such factors and it is believed that if any topographic situation is examined in the light of Cox's discussion a fairly accurate estimate of the degree of inversion and the type of altitudinal fire danger distribution should be possible.

Pacific Northwest

Adequate Fire Control on Private Lands. A report on the first sample area used in studying the fire problems of the private and public land owners in the Douglas-fir region outside the national forests was published in January under the title "Forest Fire Control

1/ Cox, Henry J. Thermal belts and fruit growing in North Carolina. Mo. Wea. Rev., Supp. no. 19. 1923.

in Western Snohomish County, Washington." This comprehensive report by Matthews and Morris contains 77 pages, 8 maps and graphs, and many tables. It is divided into two parts, the first being a detailed analysis of fire history, fire occurrence, ownership, land use, cover types, detection, organization, time elements of fire control, costs, financial support, and the relation between fire, growth, and depletion in the sample area. The second part develops specifications of adequate fire control and estimates its costs. Because of the methods of analysis used and principles of adequate fire control developed this case study of a sample unit is proving to be of interest to fire control officials and timberland owners throughout Washington and Oregon.

The study was made possible by the splendid cooperation of State and fire association officials and there is already indication that it will find immediate application. For example, the State foresters of both Washington and Oregon will probably adopt the Forest Service individual fire report form and the "Glossary of Terms Used in Fire Control" as their standard from this time forward. This action can be traced to the demonstration which the report makes of the value and importance of complete, accurate, and uniform fire records.

A similar study is under way dealing with a sample area in Oregon, the Clackamas-Marion unit. A preliminary report on the analysis of this unit was circulated in January to a limited number of the most interested individuals. Completion of a formal report on this second sample area has high priority.

These studies of private fire control problems have already been the subject of several conferences with interested officials. Matthews gave an illustrated talk at the Western Forestry and Conservation meeting in December on the problem presented in the Snohomish unit by the fact that 41 percent of the forest land is not paying any part of the cost of fire control. It is expected that both sample units will be the subject of several future conferences and short articles and many discussions with individuals.

California

Cone Protection. In recent years numerous hybridizations have been made between various species and strains of pines at the Institute of Forest Genetics and in the nearby forest. The labor entailed in this work is considerable and the seeds that may be obtained from a single cone are so few that the loss of cones bearing hybrid seeds is of considerable moment. The problem of protection from squirrels is serious, especially in seasons of light cone crop. In many instances squirrels have cut the immature cones from the branches and carried them away, or have peeled off the scales to eat the seeds, despite the heavy canvas bags used to protect the cones and catch seed that may fall from them. For this reason it has been deemed advisable to experiment with other means of protection than canvas bags. Pre-molded bags of wire screen, having mesh small enough to hold pine seeds, might be used if all cones were of approximately the same size and with the same number of cones in each cluster. However, some more flexible method of protecting the cones is necessary, for the clusters vary widely in size.

The coverings being tested at the present time are square pieces of fine-meshed wire screen, placed diagonally along the branch, then folded with all four corners drawn together at one point, and with the edges fastened by a light wire or a Bostitch stapling machine. A fusiform bag is thus provided, with an opening at each end for the branch to enter and leave, and ample space in the center for a cluster of cones. Jeffrey pine and sugar pine require almost a square yard of material for protection, while half this amount suffices for lodgepole and ponderosa pine.

Cold Injury. While taking measurements of 3-year-old ponderosa pine trees at the Pyramid transect plantation, it was observed that on occasional trees some of the needles were dead but still green in color, as the injury was so recent that they had not yet turned brown. As the distribution of this condition was somewhat localized, the data were plotted on a map to show the distribution of the trees thus affected. When this map was superimposed over a contour map of the plantation it was evident that the affected trees were concentrated on two exposed but not pronounced ridges that extend from north to south through the plantation.

The most acceptable explanation of this injury is the desiccation and freezing brought about by the cold winds along the exposed ridge. The low moisture-content of the soil along these ridges was perhaps a contributing factor. Strangely enough there was no apparent correlation between the elevation of the seed source and the occurrence of injury. Some of the plots that suffered most

were those from very high elevations, which would be expected to stand such adverse conditions better than those from lower elevations. However, in no case was the damage serious, most of the injuries representing less than 20 percent of the needles on the trees, although a few individual trees had about 50 percent of the needles injured.

Northeastern

Racial Variation. Seed Origin Studies - Norway Spruce. Fourteen seedlots of Norway spruce (Picea excelsa) were grown at the Hopkins Memorial Forest during 1940 as part of the International Forest Tree Seed Test sponsored by the International Union of Forest Research Organization.

W. O. Number	Origin
S- 1	Sweden
S- 2	Norway
S- 3	Finland
S- 4	Finland
S- 5	North Germany
S- 6	Germany
S- 7	France
S- 8	Poland
S- 9	Jugoslavia
S-10	Roumania
S-12	Roumania
S-13	Switzerland
S-14	Roumania

The various seedlots exhibited differences in leaf size and color, which in one case (Seedlot No. 12 from Roumania) was sufficiently distinct, to suggest the possibility that this may be a different species, particularly since the data sheet accompanying the seed did not give the species name. The foliage differences between the remaining seedlots were not sufficiently large in the 1-year-old seedlings to warrant quantitative study.

The four Scandinavian progenies were distinct from all others in that the terminal buds made no height growth during the first year. Growth consisted merely of an unfolding of the seedlings; at the end of the first growing season only the original seed leaves were present. On the basis of this "dormant terminal" characteristic, the Scandinavian progenies may be considered racially distinct from the other seedlots.

On the basis of height growth there is some indication that the progenies of European origin, either represent three races or one race with three major types.

Although there were statistically significant differences in percent germination and percent survival at the end of the first growing season, these differences would undoubtedly be influenced by age of seed and seed extraction and storage condition, and therefore they cannot be used as criteria for possible racial grouping. This study is handicapped by very incomplete information on the individual seedlots. Information on origin is available on only four of the fourteen seedlots, and no information is available on seed collection, extraction, and storage.

Clonal Propagation. In addition to the many factors affecting the clonal propagation of white pine (Pinus strobus) discussed in Occasional Paper No. 11, that of leaf area reduction was also found to be important. Our experiments have shown that white pine cuttings grown in outdoor propagating beds must be maintained in good growing condition well into the following summer to insure rooting. A common practice among propagators to promote greater survival through minimizing transpiration is the reduction of leaf area either by entire removal of most leaves or by clipping portions of those leaves retained. The results of experiments on the degree and type of leaf area reduction with this species indicated that any form of leaf area reduction is detrimental to immediate or ultimate survival.

Pollen Storage. Pollen of Pinus strobus and P. resinosa still shows 90 percent germination after storage of 50% relative humidity and 0° or 4° C. for 584 days. Germination of pollen stored at these two temperatures is not significantly different, but pollen-tubes produced by pollen stored at 0° C. show a significantly higher rate of growth than those produced by pollen stored at 4° C. Application of results with pine pollen storage experiments led to storage of Acer saccharum pollen for 160 days in preliminary experiments. The prospects of storing hardwood pollens for one year seem rather favorable.

Pacific Northwest

A progress report on the study of regional races of ponderosa pine has been prepared by Munger, which summarizes the observations that have been made during the past 13 years. This study involved the planting, in six localities in Oregon and Washington, of the progeny of ponderosa pine seed collected in ten different localities throughout the range of this species. The height growth shows

strikingly the inherited characteristics of the several regional races. On many of the plantations the average height of the best lots is more than twice that of the poorest lot. In all plantations the slowest growth was made by the progeny of the Harney (S.D.), Coconino (Ariz.), and Carson (New Mex.) seed. The survival of these three lots was likewise the poorest.

The lots were planted from west of the Cascades seed, one from central western Washington and one from central western Oregon. Much to our surprise there is considerable difference in the behavior of these two lots.

The range in average height of the several plantations is striking. The Washington State College plantation at Pullman, Washington, tops the series with an average height of 12.4 feet, while the plantation on the pumice soils of the Deschutes National Forest now averages only 1.4 feet.

An interesting phase of this study, which has not been covered to date but will be done hereafter, is the variation in dendrological characteristics. Already the several lots show decided difference in form of tree, bushiness, and length, color, and number of needles.

The Forest Service is indebted to the cooperation of the three local forest schools in establishing and maintaining plantations on their several school forests, namely, the University of Washington at their Pack Forest, Oregon State College at their McDonald Forest, and Washington State College on their campus.

MENSURATION

Appalachian

Volume Tables: A table for Scribner board foot volume of hemlock to a variable top diameter, as utilized, was prepared for the Regional Forester, from an equation already on hand giving volume in terms of diameter, merchantable height and form class. Form class was omitted as a variate, and the following equation resulted:

$$\text{log. Scribner bd.ft.} = 2.3905\ (\text{log. d.b.h., inches}) + 0.6365\ (\text{log. merch. ht. ft.}) - 1.6587$$

The aggregate deviation of the actual from the estimated volumes was 0.55 percent, and the average individual deviation was 12.0 percent.

Other requests for volume tables were filled by adapting tables prepared for use in the Forest Survey. Use of data from that source showed, for instance, that the standard cords of pulpwood (with bark) in loblolly pine tops, per M board feet of sawtimber in the boles, varies from 1.10 cords per M board feet for 10-inch trees and 0.55 cord for 12-inch trees, to 0.29 cord for 30-inch trees. The average is about 1/3 cord per M board feet.

Central States

Several local tables were completed during the month, based on data provided by the Ohio Woodland Survey. These included: Yellow poplar in Hamilton County, Ohio; black walnut and white oak in Franklin County, Ohio; yellow poplar, white pine and eastern hemlock in Holmes County, Ohio. Other tables are in process of computation.

Work was continued on tables for the Ohio Woodland Survey, particularly Franklin County, Ohio.

Lake States

New Tree Classification Developed. A tree classification believed to be applicable to even-aged second-growth stands in the Lake States has been developed. The classification recognizes health, form, utility, relation to surrounding trees, crown class, and crown density. (See table next page.)

By means of this classification each individual tree in the stand can readily be ranked according to its silvicultural and economic desirability.

The cataloguing of trees on study plots facilitates comparisons between similar trees and groups of trees from different plots and remeasurements and opens up a new field of study for growth and mortality records.

While not directly applicable in timber marking, the classification should be useful in training timber-sales personnel in how to choose trees to be cut and those to be left. It may be helpful in correlating marking practice of different individuals even in widely separated localities and ultimately in simplifying marking rules.

Tree Classification
for Aspen, Jack Pine, and Second-Growth Red Pine
in the Lake States

Health	A	Sound trees
	B	Damaged trees (x diseased; - defective; + dead or dying; V bent by snow, etc.)
Form	a	Straight, good form, uniform crown
	b	Poor form b_1 - crooked, forked or limby stems b_2 - one-sided or irregular crowns b_3 - "wolf" trees
Utility	s	Sawlog trees s_1 - piling
	p	Pulpwood trees s_2 - mine timber
	f	Fuelwood trees s_3 - lumber s_4 - box lumber or lagging
Relation to surrounding trees		Progressive
	1	Dominating surrounding trees.
	2	Competing with trees of the same crown class but of poorer development.
		Stable
	3	Competing with trees of the same crown class and development.
		Regressive
	4	Competing with trees of the same crown class but of better development.
	5	Competing with trees of higher crown class and development
Crown class	D	Dominant
	C	Codominant
	I	Intermediate
	S	Suppressed
	O	Open
Crown density	a	Good density Crown at least 2/3 filled.
	b	Medium density
	c	Poor density Crown less than 1/3 filled.
Symbols:		$Aas_2$1Db, $Ab_3$1Da, etc.

Pacific Northwest

Growth of Ponderosa Pine by Keen Tree-Class. Computations have been started on this study by Briegleb with WPA help, on which the Forest Insect Laboratory is cooperating.

Rocky Mountain

Stand studies - lodgepole pine. Five mortality strips, 1x80 chains in size, were established in 1938 in selectively cut stands of lodgepole pine in order to provide information on the amount and rate of mortality. Exclusive of one strip which was burned over by the end of the second season, the average annual loss per acre was 90.3 board feet. Most of the loss, however, was the result of windfall which is normally high immediately after cutting (table). Each strip represents widely different conditions, yet windfall was responsible for the greater share of mortality in each instance.

Plot No.	Total volume lost	Losses due to windfall	Losses due to all other causes	Percentage of total loss due to windfall
	Bd. Ft.	Bd. Ft.	Bd. Ft.	Percent
1	112	60	52	53.6
2	3,329	3,078	251	92.5
3	582	498	84	85.6
4	1,759	1,665	94	94.7
Total	5,782	5,301	481	91.7

Somewhat similar data for Engelmann spruce based on 17 years of record indicates that mortality in this type is high. The average annual loss was 52 board feet, 80 percent of which was the result of windthrow.

REGENERATION

Allegheny

Planting. In April, 1939, a stock grading test in loblolly pine was begun on the Eastern Shore Experimental Forest. At the time of planting, length of stems averaged 6, 7 and 8 inches for three classes. In January, 1941, they averaged 14.5, 16.5, and 18.8 inches high respectively. An analysis of variance showed these class differences to be highly significant.

Appalachian

Direct Seeding of Red Spruce, Red Pine, and Southern Balsam Fir. Direct seeding tests on the Pisgah and Monongahela National Forests in connection with reforestation experiments in the spruce type of the southern Appalachians have shown promising initial success. Seeding was done on large prepared spots, mulched and screened. The plots on the Pisgah National Forest were established in the spruce type at about 5,000 to 6,000 feet elevation, on typical cutover and burned areas with a dense cover of blackberry briars and firecherry. The results are given in the following table. Fertilized and unfertilized plots are lumped together because no real differences between them were evident.

Direct seeding 1/ on Pisgah National Forest

Species	Spots with 1 or more seedlings		Seedlings per successful spot	
	July 1940	October 1940	July 1940	October 1940
	Mean percent		Mean number	
Red spruce	89.1	83.8	4.9	4.3
Red pine	96.1	92.4	9.4	7.2

1/ Each value is a mean of 12 plots of 30 seed spots each. Twenty viable seed were sown per seed spot in late March 1940.

The October examination showed that 4.3 percent of the spruce spots and 1.8 percent of the red pine plots had been washed out by the August floods. This accounts for a large portion of the loss of spots during the summer.

Similar results were obtained on cutover and burned areas of dense vegetation in the spruce type on the Monongahela National Forest. Three broad vegetation types were sampled but as these early results showed no differences between types they are lumped together in the following table of results. Each value is the mean of all plots and 20 viable seed per spot were sown in April 1940.

Direct Seeding on Monongahela National Forest

Treatment	Species seeded	Spots with 1 or more seedlings		Seedlings per successful spot	
		July 1940	October 1940	July 1940	October 1940
		Mean percent		Mean number	
Unfertilized screened	Red spruce	94.7	92.0	7.3	6.1
	Red pine	97.0	96.6	10.7	10.0
Fertilized screened	Red spruce	92.0	88.5	6.4	5.1
	Red pine	96.7	93.5	9.3	8.3
Unfertilized screened	Red spruce	52.2	61.3	2.5	2.4
	Red pine	60.6	45.3	2.8	2.7

Some additional plots will be established on the Monongahela this spring to test further the possibilities of seeding without screens and on different kinds of prepared spots.

Direct seeding on very severe rocky sites in the speuce type where most of the original organic soil has been destroyed and where vegetation is very sparse also gives initial success. Red pine and southern balsam fir were seeded in various ways with the following results. Seeding was done in early May 1940.

Direct seeding[1] on severe rocky sites.

Treatment	Species seeded	Spots with 1 or more seedlings at fall examination	Seedlings per successful spot at fall examination
		Mean percent	Mean number
Unfertilized, screened 20 seeds per spot	Spruce	82.7	4.3
	Fir	90.0	4.9
Fertilized screened 20 seeds per spot	Spruce	77.0	4.0
	Fir	96.6	5.9
Seeded in "Osmo" cups with topsoil, screened 10 seeds per cup	Spruce	72.5	4.2
	Fir	90.0	4.7
Seeded in "Osmo" cups with topsoil, fertilized, screened, 10 seeds per cup	Spruce	65.1	3.1
	Fir	87.4	4.9
Seed imbedded in nutrient agar 12 seeds per spot	Spruce	37.9	2.6
	Fir	33.7	1.9

1/ Each value is a mean of 4 plots of 30 seed spots each.

Central States

In December Technical Note No. 23 was released dealing with effects of ground preparation on survival and growth of planted pine and black locust in southern Illinois and southeastern Ohio. While on abandoned old fields with certain soil types it has been found that the advantage occasioned by plowing persists to the end of the fifth growing season, height differences are generally small and the slight dominance of trees on plowed ground may disappear as

the trees mature. Differences in mortality are insignificant and not commensurate with the cost of ground preparation. The results indicate, however, that plowing does have a beneficial effect, especially on black locust, and on more severe sites may mean the difference between success and failure of a plantation. Ground preparation, though seldom feasible in connection with ordinary field planting, is probably justified in the case of certain critical areas on which the establishment of a forest cover is imperative but on which, by reason of soil or vegetation difficulties, tree seedlings will not survive and grow without it.

Intermountain

Planting

Ponderosa Pine: Seeding vs. Planting. Planting in the central Idaho ponderosa pine belt has never shown survival percentages that would compare with those of more favored regions, and the figures obtained for experimental plantings in 1940 would hardly seem to merit discussion. The summer was so hot and dry that all plantations were failures from a practical standpoint and survival figures were so small that statistical analysis of differences related to method or treatment was generally not warranted. The fact that the season was so extreme, however, may justify an inquiry as to what conditions or treatments yielded any appreciable survival and what relationships were suggested if not proved by even the small differences in results.

One series of three plots involved a comparison of direct seeding in spots protected by screen cones and planting of transplants from two nurseries. The test also included variables in size of scalp (none, small, and large), fall vs. spring planting, and fertilizing (none, and commercial fertilizer, alone and with barnyard manure). On one plot of the three practically no seedlings ever appeared in the seeded spots; presumably some "wise" rodents had done a thorough job of robbing the spots in spite of cone covers. On the other two plots the number of spots producing one or more seedlings was 67.5 percent of the number planted. At the end of the season "spot survival" was 5.8 percent for all spots, or 14.2 percent for unfertilized spots alone. The use of fertilizer was distinctly detrimental to both seedings and plantings; it is believed that the concentration was too strong and the manure seemed also to favor early drying out of the soil in each spot.

Survival of transplants on unfertilized spots on the same two plots averaged 5.4 percent, which suggests that direct seeding may produce better first-year results than planting on certain sites or locations. On the third plot, however, where seeding failed to

"catch", planting survival averaged 38.3 percent at the end of the year. This is a north slope plot (a relatively favorable site) but the failure of seeding is not ascribed to exposure because a north slope plot in another location had produced the best results of any direct seeding plot in 1939. In another location further evidence was given of the possibilities of seeding where the screens were effective in excluding rodents: on two direct seeding plots the average spot survival at the end of the year was 34.6 percent; on two adjacent planting plots (of another experiment, but roughly comparable) the average survival was 3.8 percent.

The possibility of increasing survival by use of older and better balanced planting stock was further demonstrated. The survival of 3-0 stock (root-pruned second year) from the local nursery averaged 22.7 percent on the three plots; that of 2-0 stock from another nearby nursery, 10.0 percent. The two kinds of stock did not differ materially in top development but the 3-0 seedlings had longer roots. Several previous tests had shown the superiority of older stock in general, but this is the first test in which both stocks were from the same local seed source.

For this particular year, fall and spring plantings gave exactly the same survival for the 2-0 stock; but spring planting resulted in nearly three times as high survival as fall planting for the 3-0 stock. The question of fall vs. spring planting is still not settled for this region. It is known, however, that fall planting should not be undertaken unless there has been sufficient precipitation to moisten the soil to a depth of 15 inches or more - which does not happen every year before snow and cold weather preclude planting.

The preparation of the soil in each spot was a benefit in both seeding and planting. The average survival on seeded spots (unfertilized) with no soil preparation other than that involved in covering the seeds was 7.5 percent, compared to 18.8 percent on scalped spots. For plantings the corresponding percentages were 13.3 and 17.9 percent. Hole planting of course necessarily disturbs the soil more than seeding. The large scalps (about 30 inches square) gave no better first-year results than the small scalps (about 12 inches square) in this test.

Lake States

Substantial Progress Made on Seed Manual. The backbone of the tree seed manual being prepared by this Station in cooperation with the Washington Office and several other Stations consists of detailed but concise information for each of some 400 tree and shrub species useful in conservation work. With the detailing of

Mirov from the California Station and McQuilkin from the Appalachian Station and the full-time help of Rudolf and Roe, over 80 of the remaining 300-odd descriptions have been written since January 1. The detailing of Miss Hughey from the Washington Office and the addition of another WPA artist has permitted the completion of many new drawings of seeds to be used in the manual.

High Water Table Cools Surface Soil Temperature and Increases Plantation Survival. Plantations and direct seeding on soils with a high water table have consistently shown a higher survival, especially after dry years such as 1937. The exact influence of this high water table upon survival has generally been overlooked, but Stoeckeler has uncovered at least one of the effects, namely the cooling of surface soil temperatures. In midsummer at 1 p.m. on a day when the air temperature in the shade was 81° F. the surface soil temperatures were found to be considerably lower when the water table was close to the surface:

Surface soil temperature (degrees F.).....	95	103	125	142
Depth to water table (feet).....	1.8	2.7	4.0	6.8

Since recently germinated coniferous seedlings often show injury or mortality from surface temperatures of 120° F., it was established that soil surface temperatures would seldom get into the lethal range for a sufficient length of time to cause serious damage from heat injury in areas where the ground water was within 4 feet of the surface.

Northern Rocky Mountain

Broadcast Versus Spot Sowing in Direct Seeding. For direct seeding, broadcast sowing has a possible advantage over spot sowing in that the individual trees of the former method are more widely spaced. With spot sowing a large percentage of the seed spots have more than one seedling. To get the most rapid growth and the best form in trees grown on seed spots, it may be necessary to thin the spots to one seedling. If such a thinning job is necessary, it may be more economical to use broadcast seeding instead of spot sowing even though the initial cost of the former might be higher. To get information on this point, a comparison was made in the fall of 1939 of spot sowing and broadcast sowing of two species, western white pine and Douglas-fir. A thallium bait and a strychnine coating on the seeds were used for rodent control as previous tests[1/]

1/Schopmeyer, C. S. Successful forestation by direct seeding using poisons for rodent control. Research Note No. 1. Northern Rocky Mountain Forest Experiment Station, Missoula, Montana. January 1940. Mimeog.

had demonstrated that these poisons were effective in controlling rodents on spot-sown areas.

The installation was made in the western white pine type on a 140-acre broadcast burned area near the headwaters of the North Fork of the Coeur d'Alene River in the Coeur d'Alene National Forest. The thallium bait was spread over 40 acres of this area on a north-facing slope about 1 month after the area was burned. Sowing of white pine seed was done 1 week after the poisoning and the Douglas-fir seed was sown 3 weeks after the poisoning. The 40-acre tract was divided into four plots of approximately 10 acres each. The first plot was spot-sown with white pine seed, the second was spot-sown with Douglas-fir seed, the third was broadcast-sown with white pine seed, and the fourth was broadcast-sown with Douglas-fir. The spot sowing was done with about 20 seeds per spot and 680 spots per acre, making a total of 15,000 seeds per acre. About 50,000 seeds per acre were scattered on the broadcast-sown area. Checks on the effectiveness of the poisons were made by comparing germination resulting from regular crew sowing with germination under screens.

The effectiveness of the poisons in controlling rodents on this area was not as good as on the two previous areas[1/] as judged by the amount of germination but in general stocking was satisfactory as shown in table 1. Germination of western white pine was below that of Douglas-fir. This difference may be attributed to the fact that white pine was sown 3 weeks earlier than the Douglas-fir, giving that much more time for rodents to find the seed. Another possible explanation is that some of the white pine seed remained dormant during the first growing season. Evidence for this explanation lies in the fact that in screened spots where rodent depredations were completely eliminated, the ratio of the number of germinated seeds of white pine to the number of germinated seeds of Douglas-fir was 1:3. A 30-day laboratory germination test on stratified seed, however, showed that this ratio was 2:3 after 30 days. The result of second-year examinations on the screened spot of white pine will determine the applicability of these explanations.

A possible advantage to broadcast sowing is that all germinated seedlings may be considered as potential established trees where in spot sowing only one seedling per spot should become an established tree. Calculations on this basis give almost twice the number of seedlings per acre on the broadcast-seeded areas as on the spot-sown areas, as shown in table 1.

Stocking resulting from spot sowing was 8 percent greater than from broadcast sowing, as shown in table 1, and the initial cost of spot sowing was about $2 per acre less than broadcast sowing.

1/ See footnote on preceding page.

Table 1.--Germination and survival on prepoisoned areas sown with poisoned seed of western white pine and Douglas-fir, fall 1939 on Coeur d'Alene National Forest

Species	Method of sowing	Spots examined[1]	Germination		First-year survival		
			Stocked spots	Seedlings per spot	Stocked spots	Seedlings per spot	Seedlings per acre
		Number	Percent[2]	Number	Percent[2]	Number	Number
Western white pine	Broadcast; screened	9	100	4.5	100	4.0	2720
	Spots; screened	225	88	3.9	87	3.8	592
	Broadcast; unscreened	112	38	2.2	32	2.0	438
	Spots; unscreened	225	51	2.0	40	1.7	272
Douglas-fir	Broadcast; screened	7	100	12.8	100	12.1	8230
	Spots, screened	225	100	10.0	100	9.9	680
	Broadcast; unscreened	130	47	2.3	43	2.2	639
	Spots; unscreened	225	90	4.6	50	3.5	340

1/ In broadcast sowing an area of 64 square feet was taken as the equivalent to one spot in spot sowing at intervals of 8 feet.

2/ Number of spots containing one or more seedlings expressed as a percentage of the total number of spots sown.

The stocking resulting from broadcast sowing, however, is satisfactory and the cost is less than the cost of planting with transplant nursery stock, although more than the cost of planting with seedling nursery stock. Hence, if it becomes necessary to do a thinning job on spot-sown areas to get optimum development of trees, broadcase sowing should be carefully considered as an alternative method. Both methods of seeding, however, should be compared to planting of seedling stock with respect to both development of trees and to initial costs.

Rocky Mountain

Laboratory germination tests of Engelmann spruce, lodgepole pine and alpine fir seed collected on the Fraser Experimental Forest have shown marked differences in germinative energy and capacity.

The rate of germination for alpine fir was very slow, that for Engelmann spruce very rapid. In 15 days the germination of spruce was completed while that for alpine fir was only one-third complete. The bulk of the lodgepole pine seed germinated rather rapidly.

Cumulative Germination Percent

Period	Alpine fir	Engelmann spruce	Lodgepole pine
Days			
15	10	80	65
30	19	81	73
60	32	81	88
90	32	81	89

Two sets of tests were conducted, one in sand flats and the other in needle litter and duff. The results paralleled one another very closely. The only difference noted was in the sand flats where many of the alpine fir seedlings pushed their roots completely out of the soil. In the litter and duff test the germination capacity was the same but seedling development of alpine fir was normal.

Southern

Planting Experiments on the Harrison Experimental Forest. During January planting was completed on nearly half of the eighty-five 5/8-acre plots allocated to this winter's regeneration program on the Harrison Experimental Forest. The Harrison management plan calls for the planting, this winter, of approximately 55 acres of old fields and uncultivated cutover land. Rather than planting the entire area with longleaf or slash pine at uniform 6 x 6 spacing, it has been divided into plots 2-1/2 chains square for the following tests and demonstrations:

Longleaf spacing (500, 1000 in square pattern, 1000 in rectangular pattern, 1500, and 2000 trees per acre)	24 plots
Slash spacing (500, 1000 in square pattern, 1000 in rectangular pattern, 1500, and 2000 trees per acre)	20 plots
Loblolly spacing (500, 1000, and 1500 trees per acre)	3 plots
Mixed species (longleaf and slash) to be burned severely at various ages (to test "insurance-value" of mixtures)	28 plots
Mixed species (longleaf and slash), unburned, to test effects of various geometrical arrangements	6 plots
Grades of planting stock (longleaf and slash)	2 plots
Effect of root-pruning on survival	1 plot
Effect of brown-spot on longleaf survival and growth	1 plot
Total	85 plots

The mixed-species plots involve a test of species-arrangement, alternate rows as against 5-row bands of each species. They will also throw light on the "insurance-value" of mixed stands in connection with hog-damage, brown-spot, and probably Cronartium. Spacing in mixture will be uniformly 1,500 trees per acre (5.4 x 5.4 feet).

A particular feature of the spacing plantations is a systematic test of growth, yield, and quality of products on old fields as contrasted with cutover lands.

The planting is being done by a WPA crew of 8 men, under the direction of Shepard. Most of the crew are rather old for the work, and accordingly slow, but their interest in both the research and the demonstration phases has been aroused, and the quality of their work is very high.

Allegheny

Silvics

A progress report on the study of swamp stands in the New Jersey Pine Barrens has been completed. Data on the successional stages on cleared areas (such as old cranberry bogs) show that:

(1) White-cedar, red maple, pitch pine, gray birch, sweetbay, and black tupelo may all invade cleared areas.

(2) White-cedar and red maple are the most ubiquitous invaders; pitch pine and gray birch frequently occur, but generally as scattered individuals; while sweetbay and black tupelo are of local occurrence.

(3) The relative importance of all species, and in particular of white-cedar and red maple, depends to a large extent on the adequacy of seed source.

(4) Provided the white-cedar seed source is as good as that of any other species, white-cedar seedlings will dominate the stand.

(5) One reason for the ability of white-cedar to capture a site, if conditions are favorable, is its production of seed at an early age. Mature cones were found on open-grown seedlings when they were only nine years old. If scattered white-cedar seedlings become established in an open area, by the time they are ten years old they will be bearing seed which will help to fill in the blanks between them.

(6) The white-cedar stands which originated on cleared areas may present either an even-aged or an uneven-aged appearance, depending largely on the age of the stand and on the favorableness of conditions for white-cedar establishment. Where conditions were unfavorable, the individuals of one stand ranged in age from 26 to 59 years and in d.b.h. from less than 0.5" to 9".

Data on successional stages of forested areas show that:

(1) The white-cedar stands are predominantly even-aged.

(2) Although under white-cedar or mixed stands a large number of white-cedar seedlings of the current year (as many as 1,000,000 per acre) often occur, older

seedlings of that species are found only under a broken overwood. White-cedar seedlings were the dominant reproduction on quadrats only on open or partially open sites.

(3) Sweetbay, red maple, and black tupelo occur, scattered through all height classes, in the white-cedar, mixed, or pure hardwood stands. (Pitch pine and gray birch are occasionally found in some stands, but their age and crown class showed that they had apparently originated under open conditions.)

(4) In some of the hardwood stands studied, the ages of individuals ranged from 1 year to at least 185 years.

(5) Evidently white-cedar is a temporary type occurring in essentially even-aged stands which must have been produced as a result of some agency creating open conditions.

(6) The hardwoods, red maple, sweetbay, and black tupelo, form the climax type in the swamp stands of the New Jersey Pine Barrens, even though these same species are also able to initiate secondary succession on cleared areas.

The factors considered of primary importance in obtaining pure white-cedar stands are (1) seed supply, which is important because white-cedar stands cover only 25% of the true swamps and little or none of the adjacent St. Johns sites; (2) light, or the creation of open conditions, which is highly essential; (3) moisture conditions. Where the water table was at nearly the same level as the mean elevation of the depressions, the seedlings in the depressions occurred at the rate of only 14,000 per acre while those on nearby hummocks were at the rate of 1.5 millions. A low water table (1.5 ft. below the ground surface) is apparently not a hindrance to successful white-cedar establishment; and all the St. Johns sites (14% of the forest area) in South Jersey could grow white-cedar stands.

Apparently seedbed is not a factor of importance. If other conditions are favorable, the seedbed is generally satisfactory.

Evidently other investigators who have regarded white-cedar as very tolerant to shade based that judgment on the number of stems per unit area. But the density of stocking depends to a great extent on the shape of the crown; and even though white-cedar has a small conical crown permitting a large number of stems per acre, it is not tolerant of shade. Nor is there any great difference between the tolerance of shade of young white-cedars and that of

older trees. Both are able to survive, but not to thrive, under a partially broken canopy. Neither young nor old individuals live very long under a stand of normal stocking.

Appalachian

Weedings in Mountain Hardwoods: Some interesting results are shown four years after weedings in a 13-year-old stand of sugar maple. In addition to the check, four kinds of release were administered to selected crop trees: light release with the weed trees cut low, light release with the weed trees cut high, heavy release with the weed trees cut low, and heavy release with the weed trees cut high. The object of the high cuts was to have the ensuing sprouts act as trainers for the crop trees.

Treated trees put on significantly more diameter growth than the check trees. At the beginning of the experiment, the mean d.b.h. of all trees was 1.17 inches. In 4 years the average increase in diameter for check trees was 0.17 inch, while the average increase in diameter for treated trees was 0.48 inch - nearly three times as much. The difference in diameter growth between treated and check trees was significant the first year of the study and has increased each year since.

As yet, the type of cutting, low or high, has had no effect on diameter growth. The degree or severity of release, light or heavy, so far has shown a statistical difference in the intermediate crown class only. That is, heavy release applied to intermediate trees showed a significantly greater diameter growth than did light release. This difference has increased in significance as the released trees grew older. It is possible that the effect of heavy release may yet become significant in the other crown classes.

Treatment up to the present has had no significant effect on height growth.

A similar study in white oak after 4 years shows that the treated trees put on 30 percent more diameter growth than did the check trees. Among the treated trees there was no significant differences between treatments; that is, between low and high cutting, or between light and heavy release. Treatment had no significant effect on height growth.

After three years no significant differences have developed for either height or diameter growth in the yellow poplar weeding study.

California

Pine Region - Harvest Cuttings.

Ponderosa Pine, Blacks Mountain. The preliminary light insect-control cutting in the Blacks Mountain Experimental Forest was extended by 672 acres in 1940, making 1,748 acres from which the trees rated highly susceptible to insects have been removed in the last four seasons. The annual loss surveys, conducted by the Bureau of Entomology and Plant Quarantine, indicate that loss reductions have been 94, 88, and 82 percent, respectively, for areas treated one, two, and three years ago. Losses in virgin timber of 63 bd. ft. to the acre in 1938, 102 bd. ft. in 1939, and about 135 bd. ft. in 1940 indicate a strong upswing in the insect cycle that should provide a crucial test of effectiveness of treatment.

A mill recovery study was completed under direction of the Division of Products for the first small sample of trees of the four insect-risk classes. The results show that, in this sample of 83 trees, the trees of higher risk were less valuable than those rated lower in susceptibility. These results suggest the possibility that economic selection and insect control are not entirely compatible. Several more of these small annual studies must be carried through, as proposed, before the results may be considered convincing.

Production and cost records for labor and equipment were maintained during the season for the cut of 2,437 M b.m. and for five different methods of cutting. Considerable interest has been expressed in comparisons of costs for different cutting methods. Such comparisons as can be made now are inconclusive because the principal factors determining differences in costs have not yet become effective. Time enough must elapse for the insects to pass the peak of their cycle and to permit a larger area to be logged before conclusions can be drawn as to the degree and period of control afforded, the value of timber that adequate control requires to be cut, the investment in roads necessary to cover large tracts, or the equipment and organization necessary.

The methods-of-cutting study at Blacks Mountain was advanced by establishing the third block of six treatments according to the plan to establish ten similar blocks, one each year. The natural-reproduction phase of this study was retarded again by almost complete failure of the seed crop.

Redwood Region. Preliminary examination of the 5-year data prior to detailed analysis has been completed for the Henry Creek reproduction study. The preliminary sorting of the seedling counts taken 5 years after logging indicates (as did previous counts) the necessity of burning slash or removing it by other means for satisfactory establishment of reproduction, and the almost complete lack

of correlation of number of seedlings with number of seed trees. Although reproduction is on the average quite satisfactory where slash has been burned, it is by no means complete. It is hoped that detailed regression analysis will help explain some of the failures and more conclusively show whether or not the number of seed trees on selectively logged areas is significant.

General observation and previous extensive surveys have indicated that vegetation may have a very definite correlation with the establishment of reproduction. In order to obtain a better understanding of the effect of vegetation on seedling establishment and to get some quantitative data to disprove or substantiate general impressions regarding distribution of vegetation, the abundance of the species present was determined for the four burn classes on north and south exposures. The following table shows the percentage of square feet on which some of the most important species were dominant in 1938 and in 1940. 1940 is the fifth year after logging and 1938 was selected because it was the peak year for Australian fireweed (Erechtites prenanthoides).

Occurrence as dominants of important species for four burn classes on north and south exposures 1/

Degree of burn	North exposure		South exposure	
	1938	1940	1938	1940
	Percent	Percent	Percent	Percent
		WHIPPLEA		
None	14	50	16	37
Light	44	58	36	64
Medium	39	71	27	56
Heavy	15	38	14	34
		OXALIS		
None	22	23	17	12
Light	13	6	10	5
Medium	2	2	4	1
Heavy	1	2	1	2
		SWORD FERN		
None	4	6	2	4
Light	0+	1	2	2
Medium	0+	1	0+	0+
Heavy	0	2	0	0+
		SALAL		
None	6	9	32	33
Light	0+	6	14	16
Medium	4	6	6	9
Heavy	2	4	3	4
		AUSTRALIAN FIREWEED		
None	40	2	18	2
Light	21	5	18	2
Medium	28	4	26	3
Heavy	38	8	42	12

1/ Expressed as percent of total net available area, on which each species is dominant.

The full significance of these data will not be apparent until the relationship with reproduction is studied. The most striking thing is the reduction in the amount of Australian fireweed from 1938 to 1940. The most unexpected result is the high proportion of Australian fireweed on unburned areas on north exposures during 1938. It has been generally assumed that this species favors newly burned sites.

Of some interest is the decrease in abundance of species (salal, oxalis, sword fern) commonly found in virgin stands as the intensity of burn increases.

Central States

Field work was completed during January on the study of logging and milling low grade hardwoods on the Sylamore Experimental Forest in Arkansas. The lumber tally of logs cut from the 225-acre timber sale was completed during December. A hundred percent tally of the residual stand and a survey of logging damage was completed during January. The results of this study are being compiled by the statistical section.

Lake States

Sleet and Storm Damaged Timber Being Salvaged: Cutfoot Forest. The salvage of the timber broken by the ice storm which swept the Cutfoot Experimental Forest last April has now been two-thirds completed. To date 580 acres have been cut over and 1,220 cords of pulpwood and 986,665 board feet of sawlogs scaled. The monetary return from these sales has been $2,605.00. The total depletion of the growing stock for the Experimental Forest resulting from this storm will be about 30 percent.

Utilization has been good, for not only was all the damaged saw timber sold but a good market was obtained for jack pine pulpwood, thus permitting the close utilization of the tops of sawlog trees and of small trees not previously merchantable. Such close utilization breaks up and scatters the slash and greatly reduces the fire hazard.

The recruise of the Cutfoot Experimental Forest was completed in December and the compilation of the data is now well under way. This cruise is not only of interest to the Station in showing the extent of the damage and in giving the present growing capital, but also to the Chippewa National Forest, of which it is a good sample.

Pike Bay Experimental Forest. Salvage sales in aspen on the Pike Bay Experimental Forest have until lately lagged. As a result of the large amount of better timber available in the locality this year, due to the windstorm of last July, aspen has not been selling well and everyone seems occupied with logging the better timber. With the early completion of salvage operations in Norway and jack pine it is believed the demand for aspen will grow, especially since the box factory with some defense orders on hand has again started to buy aspen. There is now a fair prospect that salvage of aspen at Pike Bay can be completed this spring.

Zehngraff spent January 20-25 on the Chippewa National Forest taking pictures of blowdown areas and salvage operations. One set of pictures is to be incorporated in the blowdown report and will among other things be used in the rotogravure section of a Minneapolis Sunday paper. A second set of about 100 pictures will be used as a vocational film describing current national-forest sales procedure, logging, and utilization.

Sustained-Yield Cutting Budget Met at Dukes. The sustained-yield cutting budget for the Upper Peninsula Experimental Forest was reached during 1940 for the second consecutive year. Some 500 M board feet of sawlogs, 600 cords of wood, 1,275 cedar ties, 175 cords of pulpwood, and a few miscellaneous products were scaled. Light selective cutting was practiced, removing only the more decadent and overmature trees. In all, nearly 300 acres were cut over by these salvage operations. The scaled products had a stumpage value of approximately $1,600.

A strong demand existed for hemlock and the bulk of the sawlog cut was from this species. While operations in hemlock do not produce the well-rounded cutting budget contemplated in the management plan inasmuch as no "wood" is produced, still such cuttings seem to be desirable at this time. Hemlock is represented in the stands as large overmature and defective trees that need to be cut. Many of these trees are dying each year and the quicker these stands can be logged over the greater the amount of the dying hemlock which can be salvaged. The fate of the somewhat smaller and possibly younger hemlock found in these stands is still doubtful but there can be no question regarding the dying of the large trees.

Problem Analysis for Management of Spruce and Balsam. A problem analysis is being prepared for the spruce-swamp and spruce-fir types, in order to round up what is known about spruce-fir forest management and to show what new work is needed.

From a broad standpoint, the spruce and balsam fir forests of the Lake States are scarcely more than a southern fringe of the main body of the spruce-fir type which extends from the Atlantic to

the Pacific Oceans, but locally spruce and fir are of great importance. They take in almost one-fifth of the forest land of the Lake States region, support great quantities of merchantable timber, and supply raw material for pulp mills in Minnesota, Wisconsin, and Michigan. Small quantities of spruce pulpwood are also shipped to the East.

Three species are involved: black spruce, primarily a bog tree, but which has spread to upland with the aid of forest fires; white spruce, a faster-growing, longer-lived species of fertile uplands; and balsam fir, chiefly an upland tree, short lived and less valuable than the spruces but more aggressive in its seeding habits.

Northeastern

Hurricane Damage. In considering damage by the hurricane of 1938, site, type, age class, exposure, or treatment, had little apparent effect in disturbing the ranking of the relative wind-firmness of the six important hardwood species on the Bartlett Forest. Red maple is the most susceptible to wind-throw, followed by paper birch and white ash (about the same), while beech stands up slightly better than yellow birch and sugar maple. Sprout clumps which make up a considerable part of the red maple volume are particularly vulnerable, as the combined crowns offer much wind-resistance and the root system is somewhat restricted. Until the stand approaches maturity, height growth of red maple, together with paper birch and white ash, exceeds that of the more tolerant beech, yellow birch, and sugar maple. This characteristic placed the rapidly growing species at a disadvantage, as the crowns were more exposed. White ash is ordinarily very wind-firm, but its preference for moist sites together with the 7" of rainfall preceding the storm, created ground conditions that offset this normal advantage over the other five species.

Proportionately more large than small trees were destroyed by the hurricane. This was to be expected, as the overstory of tall, slightly tapered trees that grew up under keen competition were not only well in the upper canopy but were poor risks as the small root systems were under a severe strain when the wind struck the short, dense crowns. The damage to the smaller size classes was largely secondary--tipped or broken by the falling of large trees--or if windthrown, exposed when adjoining large trees went out. A comparison of percentage, stem, and basal area losses indicates that aside from the heavily stocked spruce-hemlock-hardwood all-aged stands, trees lost were ordinarily above average size. The spread between stand and volume percentages was most pronounced in the case of red maple. The correlation of wind-throw with an increase in diameter was strikingly brought out in analyzing species losses and size classes on restricted areas (type and age class within each compartment),

in which case weighting and minor stand differences were largely eliminated.

Hurricane losses on areas in which part of the stand was removed in partial cutting operations were far in excess of losses in similar adjacent undisturbed stands. Partial cuttings provided an entrance for the wind as the broken upper canopy conditions were similar to but more pronounced than naturally occurred in untreated all-aged stands. Trees in a treated stand were not only more exposed and lacked mutual support, but a considerable interval following cutting elapses before the understory that would bind the roots more firmly is well established. Cutover stands gradually become more wind-firm, but aside from lightly treated areas where the crowns eventually close, it is doubtful if they ever regain the stability of the original uncut stand. An exception to this might be early, frequent, and heavy thinnings sufficient to alter tree form. Such treatment would probably make a stand more or less wind-resistant as this would tend to increase crown length and stimulate the development of a wide-spread root system.

Harvest Cuttings. Damage to residual trees following various degrees of partial cutting is being studied in connection with other phases of partial cutting experiments on the Gale River Experimental Forest. Some preliminary analyses have been made of logging damage data obtained on a series of 10 experimental plots from which an average of 30% of the original basal area was removed in logging operations. A total of approximately 2800 residual spruce and fir trees was examined. Four degrees of damage classes were recognized (1) total loss, (2) severe, (3) moderate, (4) light. It was found that 82 percent of the trees had escaped injury; 4 percent were lightly damaged; 5.7 percent were moderately damaged; 4.6 percent were severely damaged, and 3.7% were a total loss. No trees above 6" d.b.h. fell in the "total loss" classification. In addition to degree of damage, cause of damage was also determined. Skidding was responsible for 68 percent of the damage, felling for 29 percent, and other causes were responsible for the remaining 3 percent.

Pacific Northwest

Harvest Cuttings

Douglas Fir. A 12-year summary of studies of single seed trees by Isaac shows a mortality of slightly over 90 percent on Douglas-fir clear-cut and slash-burned areas. Windfall was the greatest single cause of loss and fire was second. Thus losses were much lower on unburned areas. Some loss was caused by insects and some by unknown causes. Isaac's further studies of life of seed in the soil substantiate previous findings that Douglas-fir

germinates or dies the first year. The same was true for western hemlock, western redcedar, ponderosa pine, Sitka spruce, and noble fir. But western white pine showed a light germination the second year and Port Orford white-cedar showed a light germination in the third and fourth years. White pine was known to hold over, but the delayed germination of Port Orford came as a complete surprise.

Ponderosa Pine. The Pringle Falls Experimental Forest was closed for the winter in the middle of December upon completion of the CCC dormitory. McKay then returned to Portland and has spent most of his time, with the aid of WPA computers, working up the three 15-acre Whitman National Forest cutting plots which were re-examined last spring. These plots, established on the Eccles Lumber Company sale in 1914, are the oldest pine cutting plots in the region. Computations completed thus far give the following disappointing growth figures:

	Annual gross growth	Annual mortality	Annual net growth
Whitman Plot 1			
Bd. ft. per acre per year	82	98	-16
Percent	.7	.9	- .2
Whitman Plot 2			
Bd. ft. per acre per year	67	51	16
Percent	.9	.7	.2
Whitman Plot 3			
Bd. ft. per acre per year	73	34	39
Percent	1.6	.7	.9
Average			
Bd. ft. per acre per year	74	61	13
Percent	1.0	.8	.2

The mortality during the 25-year period can be separated by cause as follows:

	Loss in board feet per acre from-		
	Insects	Windfall	All causes
Whitman Plot 1	54	44	98
" " 2	16	35	51
" " 3	14	20	34
Average	28	33	61

Stand Improvement.

Technical assistance was given by Kachin to the Snoqualmie National Forest in initiating a thinning and pruning project in the ponderosa pine type. A time study was carried out on a tree-climbing pruning project on the Willamette Forest, where data on 35-foot pruning by Hebo club and by saw methods were obtained. Plans were made for a pruning project and a time study was begun in a 27-year Douglas-fir stand at Wind River, where 18-foot pruning with pole saws was tested and appraised. At the suggestion of Munger and Kachin a new multiple spur tree climber was designed which is now being manufactured by the Equipment Laboratory, and was recently given a field trial. The new spur was designed on the principle of a much larger weight-bearing surface than possessed by the single-spur climber and unlike the latter will not penetrate into the wood if bark is 1/2 inch or thicker. Kachin's experiments with pruning saws showed the best manufactured saws may be made 25 percent or more effective if the saw blade is set at a certain angle with the long axis of the handle. The size of limbs and their hardness determines the best angle.

Silvics.

Phenology. A little time was spent by Munger in completing a progress report begun by Kolbe on the results of phenological observations that have been made on each national forest west of the Cascades from 1927 to 1937. The records are voluminous and interesting and it was hoped that a phenological calendar could be prepared, but this seems impossible without a great deal of scrutiny and testing of the original records. It appears that the personal element of judgment and the possible errors of sampling are so great that it is difficult to arrive at normals that are valid. Certain of the phenological events do not take place sharply at a certain time and among untrained personnel there may be considerable variation in dating events, Likewise, there is great individuality among plants and in their behavior under minute differences of microclimate and soil.

The data have been offered to the local universities for analysis since the Station cannot now do more work on them and they do afford an admirable mass of data for graduate student study. Meanwhile, it is being recommended that this project, as now conducted, be dropped, at least west of the Cascade Range, and resumed probably on a somewhat different basis when the Station can afford to give it adequate supervision. It is still our feeling that phenological observations have many valuable uses in forest and range management and that a research institution should have this basic knowledge of biotic events.

Southwestern

Control of Ips in ponderosa pine cutting. An Ips epidemic during the summer of 1940 threatened serious disturbance of the 480-acre Wing Mountain plot--one of the oldest in the Fort Valley Experimental Forest. A second cutting the previous fall had removed about 3,000 board feet of timber per acre. The slash was scattered or left in place, much of it lying in or near large groups of reproduction ranging from the seedling to the small-pole stage. Signs of heavy Ips infestation became evident in May. Ips attacks in slash are usual in this region, but in continuous logging operations fresh supplies of slash laid down from time to time attract the beetles away from living trees. In the Wing Mountain operation logging was not resumed in the spring of 1940, and therefore the stage was set for trouble. Besides, several of the large sales on the Colorado Plateau were experiencing epidemics of rather large proportions, indicating unusually bad conditions possibly associated with the dry summer of 1939.

In anticipation of an outbreak, preliminary control measures were applied by means of trap trees. About 50 green poles felled in stand improvement were laid near the worst concentrations of slash infestation. By the end of June broods in the trap trees were well advanced and on July 3 the infested poles were hauled to a central spot and burned.

Since the trap trees were inadequate to absorb all the emerging beetles, many re-entered previously uninfested, dry slash. That Ips will enter slash which has been drying for 9 months was a new observation in this region. At the same time, green saplings began to be attacked. There were two rather distinct sapling attacks--one in late June or early July when the first broods emerged from the slash, and another in August when the second brood (resulting from re-entrance) emerged.

During the summer 60 focal points of sapling attack were located in the plot, the largest spot being about 100 feet square. Observations revealed that, once started, these spots enlarged rapidly. Control measures consisted of prompt cutting and burning of infested material, and in addition leaving a few freshly cut poles as trap trees to be burned after they had absorbed the remaining beetles. This method, though laborious, proved effective in that no reinfestation followed in the spots thoroughly cleaned up in the manner described.

The poisoning of about 300 worthless trees in June may have intensified the insect activities. During the 5 previous years in which tree poisoning has been practiced in stand improvement, bark beetles have given no trouble at Fort Valley, although there

was minor activity on the Lincoln where a general Ips infestation was in progress at the time the trees were poisoned. During July and August great numbers of beetles were found in the tops and limbs of dead and dying poisoned trees on the Wing Mountain plot. Few beetles entered the lower portion of the bole. No broods were developed, possibly because of the rapid drying of the standing, poisoned trees as compared with slash on the ground.

In some instances sapling stands surrounding poisoned trees were attacked, in others not. The reasons for this difference are not known. Apparently, however, the poisoned trees attracted the beetles and the difference in behavior toward saplings may have been related to the number of beetles present. In some instances saplings were attacked with the first influx of beetles; in others the beetles apparently first entered the standing, poisoned tree, then emerged and attacked nearby live trees which ranged all the way from 1 inch to 8 inches d.b.h. A few of the poisoned trees were felled and charred, but this proved unnecessary because the beetles left of their own accord without developing broods.

Whether or not the poisoned trees contributed toward increased beetle activity, the experience offers some useful suggestions. It is doubtful whether the poisoned trees would have been attacked at all had not a large insect population been built up in advance. In future stand improvement operations following logging, it seems advisable to time the poisoning so it will take place while the slash is still fresh. Waiting, as in this instance, until the slash is dry tends to prolong beetle activity by providing a supplementary supply of food for the emerging beetles, though not sufficient to divert them from live trees.

Regardless of stand improvement, Ips activity is more dangerous in isolated cutting than in continuous large-scale operations. Since logging in the experimental forest is necessarily of the former class, Ips control must be taken fully into account in planning future logging operations. Burning the slash before the Ips broods emerge should be helpful but is probably inadequate because most of the broods will be found in the tops, large limbs, and cull logs. Peeling or charring these large members would be expensive. A plan which has possibilities is to leave a small portion of the timber on each tract, to be cut in the year following the major operation. A thorough clean-up of infested material in the supplementary cutting would be possible since the volume would be small.

Douglas-fir. During a month's trip in September to the California, Pacific Northwest, Northern Rocky Mountain, and Rocky Mountain Stations, Krauch gathered silvicultural and regeneration information of much value to the Southwestern Station and Region 3.

While made primarily to obtain first-hand information regarding objectives and problems in the management of the Douglas-fir type and to see some of the cutting operations and experimental work that is being done in this type, the trip also afforded an opportunity to see and to discuss experiments that are being conducted in the Ponderosa Pine, white pine, lodgepole pine, and redwood types. Besides visiting several experimental forests and private sales areas, brief visits were also made to the Institute of Forest Genetics, the Savenac and Monument Nurseries, and the Pikes Peak plantations. To have seen and learned so much in so short a time was made possible because of the efficient execution of the field trips, planned and personally conducted by staff members of the various experiment stations.

FOREST PRODUCTS

FOREST PRODUCTS STATISTICS

California

Forms covering the 1940 lumber census were distributed January 22 to a list of about 450 operators.

Northern Rocky Mountain

Wholesale Lumber Prices. The latest lumber prices compiled by the Division of Forest Products appear below. There has been a heavy demand for current prices recently from various sources. Although January figures are not yet available, it is reported that prices followed a more even keel and the sharp upsurges which characterized the last quarter of 1940 are not apt to be repeated in the immediate future.

Average Wholesale Lumber Selling Prices 1/
(N. E. Washington, Idaho, Montana)

	Average 1939	Average 1940	Oct. 1940	Nov. 1940	Dec. 1940
Idaho white pine	30.36	33.06	34.60	35.61	35.50
Ponderosa pine	24.32	26.97	26.76	28.46	29.72
Larch and Douglas-fir	18.93	21.20	22.31	23.29	22.45
White fir	15.72	19.50	20.23	20.86	22.96
Engelmann spruce	20.01	23.55	24.33	25.70	28.17
Western redcedar	24.12	25.20	27.88	21.06	32.12

1/ Prices include commissions and discounts.

Christmas Tree Production in Western Montana in 1940. A new peak was attained in Christmas tree cutting in western Montana in 1940, according to statistics gathered by the Division of Forest Products. The estimated cut for 1940 was 2,338,350 trees compared with 1,967,350 in 1939, the previous banner year. Practically all of the trees shipped were Douglas-fir.

Census of Lumber Production. Early in January schedules were sent to 747 operators and at the end of the month returns had been received from 314, or roughly 42 percent. Second requests have been mailed to delinquents. Most of the larger sawmills have not yet reported and it is too early to make an estimate of the 1940 cut. An increase of about 10 percent over 1939 is expected, however.

Pacific Northwest

Prices. Average log and shingle prices were compiled. Log prices were compiled from monthly quotations as given in The Timberman and shingle prices from the Red Cedar Shingle Bureau market reports.

TIMBER HARVESTING AND CONVERSION

California

Mill Study on Trees of Different Insect-Risk Classes. Analysis of data on the mill study at Fruit Growers Supply Co., Susanville, on trees of different insect-risk classes, as defined by the Bureau of Entomology, Berkeley, taken from the Blacks Mountain Experimental Forest was completed and report prepared. While the study was not of a wide enough scope to permit drawing definite conclusions, it indicated that high-risk trees are not necessarily high-value trees. In fact, in the particular sample studied they averaged lower in value than the low-risk trees. It is planned to check the results in another study during the coming year.

Pacific Northwest

Mill Studies-Ponderosa Pine. The report of the study at the Ellingson Lumber Company, Keno, Oregon was completed and distributed to the cooperators.

Mill Studies - Douglas-Fir. Field work on the first of a contemplated series of mill production studies in Douglas-fir was conducted during December and January. Some of the study lumber was side-tracked because of stacker trouble and is just now on its way through the kilns. Data were obtained on two hundred and forty 32-foot logs, ranging from 13 to 54 inches in diameter, and from No. 3 to Peeler in grade. As reported last time, these logs were graded under the rules now in effect on Puget Sound and by a representative of the Pacific Log Scaling Bureau. All boards were graded green and rough-dry, and samples were taken to indicate additional changes occurring during surfacing.

FOREST AND RANGE INFLUENCES

FLOOD CONTROL SURVEYS

Allegheny-Northeastern

General. Humus studies in the northeast region have yielded some significant findings.

1. In stands of equal crown density and age, but with different diameters, those with fewer and larger trees build up greater humus depth.

2. Indications are that "mor" humus types absorb and retain as much or more water than mull types in the Connecticut watershed.

3. Following clear-cutting the humus depth will decrease for approximately 20 to 30 years after which it will begin to be built up and reach a 3" depth in 45 years for the climax vegetative types and 65 years for the temporary vegetative types.

A relatively constant ratio was found to exist (on different vegetative covers occupying the same soil type) between the data obtained by the use of the type FA infiltrometer and data obtained by the type F equipment which in turn can be correlated with runoff from gaged small watersheds; hence, this makes a fairly reliable method for calculating infiltration values from the FA data in terms of the F data.

A statistical analysis of the infiltration work to date on the Upper Susquehanna indicates that data obtained from the well-drained forest complex are of no value, because the water is absorbed as fast as it can be applied, but apparently merely spreads out below ground instead of soaking in vertically. This finding was in complete agreement with the findings of the infiltration work on the

Allegheny River. However, this was the only soil cover complex that showed such indications.

Watershed Surveys

Connecticut. The stage discharge frequency studies are continuing and work has been started on the analysis of discharge records on the gaged watersheds. Records to date seem to indicate significant differences in stream flow under various types of cover. It is believed that peak runoff from open areas may be 10% to 15% higher than that from forested areas. The records to date cover 10 small storms. While recession curves seem similar for all cover types under winter conditions, there appears to be a longer recession curve in forested areas under summer conditions.

Upper Susquehanna. Snow surveys and stream flow measurements on small gaged watersheds and infiltration runs for both type FA and F infiltrometers disclose significant differences in the infiltration capacity between major soil cover complexes. Future plans should include the collection of sufficient range of infiltration capacity from the gaged watersheds in order to construct an average infiltration curve. The differentiation of this curve by either the Horton or the Sherman method should give the true infiltration curve. This curve then could be used to check the infiltration curve obtained by the infiltrometer; thus, present indications are that it is possible to obtain accurate results for a wide range of soil and cover strata by combining the flexibility of the instruments with the accuracy of the gaged records.

Central States

Muskingum River detailed survey report has been completed.

Preliminary Examination

Scioto River. Considerable time was spent regrouping sample data to find a method of applying present and proposed land use in the various soils and physiographic divisions of the watershed. Land use changes and practices have been determined. Costs and benefits of these changes have been computed as a basis for the cost-benefit analysis.

Wabash River. Infiltration studies in the field have been completed for the season. Results have been partially analyzed. These were checked by Diebold who also made a field inspection of the sites where the tests were made. Core samples, collected while

the infiltrometer was in operation, have been tested in the laboratory for permeability and absorption. Results of these tests are being analyzed at Dayton.

Representatives of the Soil Conservation Service and Forest Service made a trip through the watershed for the purpose of checking the map showing land use program areas previously delineated by the soils men. Plans were also made for inspection of S.C.S. camps and project cooperating farms to determine their suitability as samples of possible land use changes in the watershed.

Cumberland River. Physical data on the Cumberland has been brought to final stages of compilation. The distribution of land by capability classes based on soil type, degree of erosion, and slope gradient of sample areas, has been determined for major subdivisions of the watershed.

Summarizing of present land use data and preparation of recommended changes in land use are in process. Field work on flood damage surveys by the B.A.E. and on sediment damage by the S.C.S. is complete, and the data collected are being analyzed.

Meramec River. Field work and office computations have been completed.

Sny. Field work on this small series of watersheds in Northwestern Illinois is 80 percent complete.

Little Sioux Detailed Survey. Richman, senior representative on the Little Sioux Survey, is starting forestry studies, having devoted all his time previously to the infiltration work. All field work has been handicapped by bad weather. The unusually severe blizzard of Armistice Day wrecked the type "F" infiltrometer. Recorded wind velocities exceeded 85 miles per hour. As field work cannot be completed prior to September 1, it is probable that the survey report will not be submitted earlier than December 1.

Lake States

The detailed survey report of the Kickapoo was submitted to Washington. The field committee members were not able to come to unanimously acceptable conclusions; therefore the report was accompanied by a statement of exceptions.

A meeting was held on January 3 at the University of Minnesota to acquaint the faculty members with the work being done and the programs proposed for the Whitewater watershed. The meeting was attended by the entire field crew of the survey and by a large

representation from the University faculty. The different members of the field party explained the techniques employed and the results obtained in the several branches of the survey. In the afternoon the several proposed programs were discussed and faculty members took an active part in the discussion.

Average areal infiltration rates for 7 sub-drainages of the Whitewater River were calculated as a result of data collected during the storm of July 11, 1941. These rates are based on records from 11 recording rain gages. The results bring out sharply the limitations in the use of this method. It is planned to prepare a manuscript covering this study.

Pacific Northwest

Walla Walla Watershed Survey. The compilation work is in the final stages and charts and tables for the report are being prepared. It was decided to supplement the flood control report with a program of conservation for the natural resources on the watershed. Chandler Jensen is handling this phase of the work which involves the preparation of a forest management plan, a range management plan, a fire plan, and a game management plan. The basic data essential to the preparation of these plans are now being compiled.

INFLUENCE OF NATURAL VEGETATION ON STREAMFLOW

California

The data for the season 1939-40 have been summarized for the North Fork, Bass Lake, and Berkeley installations. The outstanding characteristic of the season at these stations was the super-normal rainfall with only low to moderate intensities.

North Fork

Plots. The 1/40-acre surface run-off and erosion plots received about 41 inches of rain, 8 inches above normal. The run-off from the plots burned annually until 1938 and unburned since then was less than 2 percent of the total precipitation, from the twice-burned plots less than 1 percent of the precipitation, and from the undisturbed plots none. The erosion rates were 75.0 pounds per acre, 6.0 pounds per acre, and none, respectively.

On the pair of 1/100-acre plots burned annually since 1936, the surface run-off was equal to over 5 percent of the precipitation and produced erosion at the rate of 645 pounds per acre. The undisturbed pair had no run-off or erosion during the season.

Ten runs, employing artificial rainfall at rates from 1.5 to 3.5 inches per hour and totaling 26.7 inches, were made on the pair of 1/100-acre burned plots. The run-off was approximately 64 percent of the precipitation and produced erosion at a rate of over 14 tons per acre. Similar runs on the undisturbed pair of plots produced no measurable run-off or erosion.

Lysimeters. The seasonal summary for the sloping rectangular lysimeters is given in the following table. The very marked influence of a litter cover on the amount of run-off and evaporation is again substantiated. In addition, the ability of litter to reclaim the infiltration capacity of a badly eroded soil is demonstrated. Lysimeters 12 and 14 reacted very much alike when covered with litter--a few years without litter and 14 responds like 13 which has been exposed for years. Conversely, lysimeters 13 and 15 reacted alike when both were bare but 15, after a few years with litter, now reacts like 12.

Sloping Rectangular Lysimeters
1939-40 Precipitation = 41.44 Inches

Lysimeter	12	13	14	15
Treatment	Soil surface continuously under litter	Soil surface continuously bare	Soil surface originally litter covered Burned in 1937 Bare since 1937	Soil surface originally bare Litter covered since 1937
	Inches	Inches	Inches	Inches
Surface run-off	0.6	20.9	26.7	1.6
Percolation	34.1	6.5	3.8	32.9
Evaporation	6.7	14.0	11.0	7.0

In September 1940 the litter was burned from lysimeter 15, and lysimeters 14 and 15 were sowed to Bromus mollis.

The level surface circular lysimeters showed from 5 to 6 inches more evaporation and less percolation from the grass covered than from the bare soil surfaces. Had these tanks been constructed to permit free surface run-off comparable to that from an undisturbed soil surface, there would have been a greater difference in surface run-off between the grass covered and denuded soils and therefore less difference in evaporation and percolation.

Interception. The interception study for the Aesculus type on the undisturbed 1/40-acre plots gave results for the 1939-40 season comparable to the previous years and was discontinued in September 1940. A second study was begun on the undisturbed 1/100-

acre plots on which the dominant vegetation is Ceanothus cuneatus. The plots are equipped for measurement of the effects of rain intensities and duration of rain on interception losses.

Soil Moisture. The soil moisture studies at North Fork have been discontinued as of September 1940 with the exception of occasional sampling to give a rough picture of soil moisture progression with the season.

Note: Results of the 1939-1940 season on Bass Lake and Berkeley watercycle installations will be presented in the April report.

San Dimas Experimental Forest

Penetration of Rainfall Into Soil. During October 1940, shortly before the first storm of the current season, five sites were selected for periodic soil moisture sampling in Watershed Ten (Monroe Creek). Since that time, at frequent intervals, additional samples have been taken to trace the penetration of rainfall through the soil column. The sample spots are distributed widely over the watershed and represent several conditions of vegetation and exposure.

Prior to the first storm, the soil moisture ranged from 1.8 to 8.8 percent, averaging about 4.5 percent. The rainfall of the first storm, nearly 2.5 inches on October 24-28, penetrated rapidly to an average depth of about 19 inches, with a range of from 6 to 30 inches below the soil surface. This penetration remained fairly constant despite an additional rainfall of 1.5 inches on November 17-18. During the latter half of December about 9 inches of rain, falling in several storms of rather low intensity, added considerable moisture to the soil. On January 3 the penetration had reached an average depth of 40 inches plus, and by January 15 an average depth of 48 inches plus. During the samplings on January 15 only one station was found with soil depth exceeding the penetration of the new seasonal moisture. At this station dry soil was encountered at a depth of 62 inches.

Between October 24 and January 15 the total seasonal rainfall over the Experimental Forest averaged about 13.5 inches. Since soil borings to date indicate an average soil depth over the Forest of slightly more than 12 inches, this was taken as a critical depth for expressing rainfall penetration. Computations on the basis of the periodic soil moisture samplings indicate that, of the average rainfall of 13.5 inches which fell on the Forest between October 24 and January 15, approximately 4.5 inches passed below the 12-inch depth of soil. Streamflow started at the mouth of Watershed Ten after about 9.5 inches of rain had fallen.

Shrub Species and Soil Moisture. Last September a site was selected for a "pilot" test of soil moisture sampling to explore its possibilities as a means of investigating the influence of different shrub species upon the infiltration and penetration of rainfall. The spot chosen was an exceptionally deep soil deposit, bisected by the Dalton Road about 1/2 mile above Tanbark Flat, which appears to have been formed during some ancient mud flow. On the surface of this soil mass there occur in juxtaposition an area of nearly pure Adenostoma fasciculatum, a small area of Quercus dumosa, an area of nearly pure Ceanothus crassifolius and an area of bare soil cleared several years ago. Soil moisture samples were taken in each of these "types" in September 1940 before the first storm of the season. At that time the moisture content of the soil ranged from 1.2 to 7.3 percent by weight. It was uniformly less under the Ceanothus than in any of the other areas. The first storm (2.5 inches) caused penetration from 9 to 15 inches in depth and the new moisture remained at this level until after the heavy rains (8.35 inches) during the latter half of December. Sampling on January 4 showed moisture penetration to a depth of 30 inches under the bare area, 40 inches plus under the Adenostoma fasciculatum, 45 inches under the Quercus dumosa, and 46 inches under the Ceanothus.

On January 16 the penetration depth under the bare area and Ceanothus remained the same, but under the Adenostoma fasciculatum it has increased to 50 inches and under the Quercus dumosa to 55 inches. A computation of the amount of water passing the 12-inch depth under each of the areas disclosed the following:

Bare area	1.75 inches
Ceanothus	2.30 "
Quercus dumosa	3.13 "
Adenostoma fasciculatum	3.48 "

Soil sampling will be continued at this site throughout the spring and summer to obtain measurements on the rate of withdrawal of moisture from the soil.

A similar program of soil moisture sampling has been carried out at the Tanbark Runoff and Erosion Plots. Two sampling areas were selected, one under the brush canopy with a crown density of 70 percent, a litter depth of 1½ to 2 inches, and no herbaceous cover. The second area is in the open with a sparse annual herbaceous cover of 2 percent density and with a litter depth of 2 to 3 inches. Samples were taken by 3-inch depth increments using an Iwan post hole auger 2 inches in diameter. Soil moisture samples were taken at 10-day intervals between storms and 72 hours after each rain. The soil moisture content ranged from 2 percent at the surface to 4.5 percent at 72 inches depth, at the start of the rain season. Rainfall penetration during the winter is indicated in the following tabulation of rainfall and depth of new moisture penetration:

Tanbark Runoff Plots	10/29/40 Inches	11/22/40 Inches	1/3/41 Inches	1/15/41 Inches
Cumulative rainfall	2.31	4.06	12.41	13.03
Penetration under brush canopy	8.00	11.00	26.00	28.00
Penetration in the open	14.00	16.00	41.00	48.00

These differences in penetration suggest a considerable amount of interception by the canopy which in this case is composed chiefly of Ceanothus species.

The water content of a 48-inch column of soil under the two conditions described above is shown as follows:

	Inches of Rain		
	10/9/40	1/15/41	Difference
Under canopy	1.80	5.57	3.77
In open	1.80	6.93	5.13

From the above table it is estimated that an average of approximately 4.45 inches of water has passed into the soil. The reader is again reminded that these soil moisture figures are merely preliminary indications from small-scale "pilot" tests and should not be regarded as conclusive data.

New Glendora Headquarters.

The Station and the Angeles National Forest joined in celebrating a community event at Glendora on January 24 when the new Forest Service headquarters in that city was opened for public inspection. The site for the headquarters was donated to the Government by the citizens of Glendora and the building was constructed through aid from the Work Projects Administration. This building is now jointly occupied by the San Dimas Experimental Forest staff and the Mount Baldy District Ranger of the Angeles Forest.

At the annual dinner meeting of the Glendora Chamber of Commerce held during the evening of the twenty-fourth, the Forest Service presented a program describing forest conservation activities in the San Gabriel Mountain area. J. D. Sinclair, in a dual capacity as head of the Experimental Forest staff and a director of the Glendora Chamber of Commerce, introduced the Forest Service people to the townsfolk. C. J. Kraebel, representing the Station, gave an illustrated description of watershed management investigations in progress on the Experimental Forest and their relation to the Department's flood control program. Assistant Supervisor Armstrong described the local work of the Angeles National Forest, and Captain Cadwell the activities of the C.C.C. in both the experimental area and the national forest.

Northern Rocky Mountain

As part of its program for securing complete data concerning timber cutting, the results of timber cutting, the occurrence of all meteorological phenomena and their effects, on our experimental forests, the Northern Rocky Mountain Station in the fall of 1938 installed equipment for measuring rainfall on and runoff from a 960-acre forested mountain watershed on the Priest River Experimental Forest. With only limited facilities and personnel available 2 years of measurements have been confined to continuous records of runoff and precipitation from recording instruments with additional summer records of rainfall amount and distribution from nonrecording rain gages.

The 1½ square mile forested watershed ranges in elevation from 2,640 to 5,510 feet and is 2¼ miles long with an approximate mean width of 0.7 mile. Approximately 19 percent of the drainage basin has an essentially western aspect, 23 percent south and southwestern aspect, and 58 percent north and northwestern aspect. The area is drained by Benton Creek, a perennial stream 2.1 miles long with an average gradient of 19 percent from its source to the gaging station.

Runoff from the area is measured by a Stevens model KW automatic 8-day waterstage recorder over two Cipolletti weirs built into a concrete dam on Benton Creek. The dam was constructed with CCC labor and funds in November 1938 and runoff records have been continuous since December 12, 1938.

Continuous records of precipitation intensity, duration, and quantity are secured from two #775 Friez recording gages which use weighing buckets for both rain and snow. One of these gages has been operated at the gaging dam, elevation 2,640 feet, since November 21, 1938. The second gage was operated at an elevation of 4,700 feet from May 22 to December 4, 1939, but then was moved to an elevation of 3,520 feet where the gage is accessible for year-long operation. From 1 to 13 Weather Bureau standard and Forest Service type rain gages were exposed on the watershed at various elevations from varying periods from April to December 1939. Complete measurements for June, July, August, September, and October 1940 were obtained from 11 rain gages located on the watershed at elevations of 2,980, 3,160, 3,490, 3,780, 3,840, 4,000, 4,280, 4,640, 4,700, 4,900, and 5,500 feet.

The records of runoff and of precipitation have just been compiled by Superintendent McKeever, who installed and has operated the equipment, for the period January 1, 1939 to December 31, 1940. The compilations show the daily total and storm total discharges in cubic feet, the mean daily discharge in cubic feet per second per

square mile of watershed, and the monthly total in inches per square mile. The precipitation charts from the recording gages have been compiled to show the hourly precipitation, the maximum depth and intensity for intervals of 1, 2, 4, 6, 8, 12, and 24 hours, and the storm total, the daily total, and monthly rainfall on the watershed, weighted areally by the Thiessen method.

At the request of the hydrologic division of the United States Weather Bureau Office at Portland, Oregon, a tabulation of the hourly precipitation measured by the recording rain and snow gage at the stream-gaging dam is sent to the Portland Weather Bureau at the end of each month for inclusion in their monthly precipitation summaries. Two snow courses also are operated within this drainage in cooperation with the Soil Conservation Service. No funds are received from any agency for any of this work.

Rocky Mountain

Rainfall Interception. In the December report (page 76) the tentative results of a study of rainfall interception in lodgepole pine were discussed. Since that time the analysis has been completed and more definite results are available, together with recommendations for the design and analysis of future studies of rainfall interception.

To summarize the study briefly: In 1938 five Forest Service rain-gages were placed on each of 20 plots supporting the lodgepole pine type. One of these gages was installed in a large crown opening taken at random from all available openings in the plot; the other four cans were set at a distance of 66 feet from the "open" gage, in each of the four cardinal directions. Rainfall records were taken in all gages after each summer storm (May-October) for three seasons.

For treatment, the plots were grouped in four blocks of five plots. After two seasons of records, four plots in each block were cut-over, leaving commercial reserve stands of zero, 2,000, 4,000, and 6,000 board feet per acre; the fifth plot in each block was left in virgin condition.

Results are summarized below (a more complete table appeared in December).

Interception in Lodgepole Pine
(Percent of season's rainfall)

		Reserve stand				
		Virgin	6000	4000	2000	Zero
Before cutting	(1938	32.4	25.6	31.6	28.2	27.8
	(1939	34.6	30.6	30.1	28.4	27.0
After cutting	1940	28.6	11.5	6.8	10.3	8.5

A striking feature of this table is the very low interception measured in the "4000" group of plots; actually lower than that found in the clear-cut plots. A logical reason for this discrepancy is weakness of the sampling procedure, due to the clustering of all gages at one small area in each plot; even the four replications apparently failed to iron out the trouble. It is interesting to note, too, that apparently the discrepancy is purely the result of cutting, as the questionable plot group showed reasonable agreement with the other plots before cutting. In this one group of plots, the cutting must have been unusually heavy around the rain-gages in each plot, so as to give the effect of commercial clear-cutting rather than of a 4000-foot reserve stand.

In order to determine the influence of storm size as well as treatment and block effects on interception, the data were analyzed by covariance, using the average of each 4-gage group to measure interception. Results showed no differences between plots in each block before treatment; a significant variance between blocks both before and after treatment; and a highly significant effect of the cutting treatments on interception. The regressions of "net" rainfall (precipitation in the "interception" gages) on storm size showed a regression coefficient (b) of 0.8114 before cutting, with a correlation coefficient (r) of 0.990; corresponding values after cutting were 0.9209 and 0.994. Neglecting the interesting changes in regression due to cutting, the correlation coefficients held to point out defects in the study. Since the rain-gages were kept in the same place throughout the experimental period, the "error" of these regressions measures only variance due to storm variability and gives no clue to the true experimental error of the investigation. Also, since all four "interception" gages in each plot were in relatively the same spot and were compared with the same "open" gage, it was considered best to use their average in analysis; hence, there is no thoroughly reliable measure of variability within plots. For these reasons it was necessary to use the "block-treatment" interaction--with only 12 degrees of freedom--for testing treatment effects.

Based on all of these considerations, careful thought and discussion have led to the following recommendations for future interception studies, which should apply equally well to experiments in other forest types:

1. After selection and tentative mapping of the study area, select a group of gage locations from all sites available for an "open" gage. If possible, locate five to ten times as many gage sites as the number of paired gages to be read. Stratify the area, if possible, to reduce sampling error. This may be done by arbitrary subdivisions, by topography, exposure, tree species, or other measurable criteria.

2. Pair the gages: for each "open" gage, install one interception gage by random selection of nearby sites under trees.

3. After each storm, move each pair of gages to a new site, selected by randomization.

4. Analyze the results by covariance, using storm size as the independent variable. Assuming a layout of 30 gage pairs, distributed in four blocks (or strata), with five treatments (or species) in each block, with six gage sites selected for each block and treatment (or species), and with 12 storms recorded, the covariance analysis would be as follows:

Covariance Table - Rainfall Interception

Source of variation	Degrees of freedom
Total	239
Between: blocks (or strata)	4
treatments (or species)	3
Interaction (experimental error, if randomized blocks are used)	12
Within blocks and treatments (sampling error for stand variation)	120
Remainder	100
For regression (sampling error for storm variation)	99

A plan such as this should be much more efficient and provide more reliable results than those of the present study. From the viewpoint of labor, the task of moving cans would be partly offset by the need for fewer gages.

Experimentally, the treatment means should be on a much sounder basis, and experimental error should be reduced to a minimum. In addition, such a study should provide interesting information on the components of sampling error due to stand variability and to variation in rainfall characteristics as well as on the influence of storm size on interception. The most attractive feature of this kind of experiment, though, is the fact that relatively few storms should be needed for a complete study of any forest area; only enough to provide a reasonable range in storm size.

Southwestern

Precipitation and Evaporation in the Oak Woodland Zone. Precipitation on the Sierra Ancha Experimental Forest during 1940 was unusual in several respects. The fall for the first quarter of the year--January, February, and March--was abnormally low, amounting to only 5.63 inches at the Parker Creek Station. Similar conditions prevailed over the Salt River watershed, and as a result run-off was much below average. This was followed by the usual spring and early summer dry period, which in this instance lasted until July 15. By this time, water storage reservoirs on the Salt and Gila Rivers were practically dry. Summer rainfall of 10.49 inches was considerably above average, but afforded only very slight relief from the water shortage. However, several good rains fell in October and November, months which normally have little precipitation. Exceptional rainfall of 8.69 inches in December boosted the year's total, as measured at the Oak Litter Lysimeter Plot, Parker Creek Branch Station, to 32.69 inches, about 7.50 inches above the average fall. These December rains resulted in greatly needed replenishment of irrigation reservoir supplies; storage on the Salt River system rose to more than 800,000 acre-feet by February 1, 1941.

The occurrence of rains at frequent intervals throughout the summer and fall periods afforded an opportunity for study of evaporation losses from five small lysimeters located in the oak woodland zone. These lysimeters, containing natural soil blocks, are of two sizes. Numbers 1, 2, and 3 (table 1) have a surface area of 500 square inches and a depth of 22 inches; numbers 4 and 7 have a surface area of 1,000 square inches and a depth of 28 inches. The blocks were taken from a diabase soil area and represent two conditions of ground surface, bare and litter covered. All lysimeters have a surface slope of 25 percent facing to the northwest, but are exposed to full sunlight during the greater portion of the day.

The data under heading 1 in table 1 give the calculated amount of water infiltrating into the soil during the various periods of the year. In making these calculations, precipitation less surface

run-off was assumed to equal infiltration. A fresh covering of leaf litter, which was added to lysimeter 3 in the spring, had a pronounced shingling effect during heavy summer rain storms, resulting in low infiltration on this particular lysimeter. This effect gradually disappeared as the leafy material settled and began to disintegrate. Except for this and one or two minor exceptions, infiltration was much greater on the two litter covered areas than on bare ground.

The percentage of precipitation infiltrating into the soil was considerably higher in winter than in summer, as fall of rain is much less intense in winter.

Lysimeter blocks were thoroughly wetted by January and February precipitation, as indicated by the high amount of seepage or percolation flow. By subtracting percolation flow from the amount which infiltrated into the soil, it was possible to determine with reasonable accuracy the evaporation draft for the year. The average percentage loss of infiltration water, 19.6 percent, is quite low for the January 1 to February 10 period, but rises rapidly as the weather increases in dryness and warmth. Percentage loss remains very high throughout the summer period, but declines in the fall and becomes extremely low in December when an average loss of only 13.6 percent is recorded.

Actual loss in inches by periods shows summer loss to be very high, spring loss low as a result of small amount of precipitation rather than evaporation rate. Monthly evaporation losses from a free-water surface during May and June were 9.24 inches and 10.64 inches, respectively, indicating a very high evaporation draft for this period. Had more rain fallen in May and June, losses would have been proportionately higher, as all of the available water in the lysimeters would have been lost through evaporation.

Although run-off from bare areas amounted to about 50 percent of the summer precipitation, this is no indication that surface run-off contributes materially to summer yield. Even the above-normal summer rainfall of 1940 contributed little to streamflow; flow on the 700-acre Parker Creek watershed amounted to only three-tenths of 1 percent of the precipitation. The greater portion of surface run-off from small and localized areas is absorbed by dry channel beds which usually dry out again before the next run-off appears.

The figures under the heading "evaporation loss" do not, of course, reflect the full loss for any particular period. This could be obtained only by weighing the lysimeters at frequent intervals. After the lysimeters began drying out in April and May, they were not, with the exception of the litter covered blocks, fully recharged again until in November. The amount of evaporation during summer is

Table 1.--Lysimeter studies of precipitation, infiltration, percolation, and evaporation in the oak woodland zone, Sierra Ancha Experimental Forest

Lysimeter No. / Condition	Precipitation Inches	Infiltration in inches (Precipitation less surface run-off) 1 Bare	2 Bare	3 Litter	4 Litter	7 Bare	Average	Percolation in inches (Seepage) 1 Bare	2 Bare	3 Litter	4 Litter	7 Bare	Average
Periods													
Jan. 1-Feb. 10	4.51	3.14	3.03	4.11	4.20	3.41	3.58	2.42	2.22	3.37	3.63	2.75	2.88
Feb. 11-Mar. 31	1.12	1.12	1.12	1.11	1.11	1.12	1.12	.45	.46	.41	.51	.60	.49
Apr. 1-May 31	1.49	1.28	1.35	1.10	1.18	1.31	1.25	.07	.16	.04	.07	.20	.11
June 1-July 15	.48	.47	.46	.48	.48	.48	.47	0	0	0	0	0	0
July 16-31	2.13	1.84	1.48	1.57	1.89	1.67	1.69	0	0	.03	0	0	.01
Aug. 1-31	4.65	2.34	2.03	1.84	3.19	2.60	2.40	0	0	.23	.94	0	.23
Sept. 1-30	3.23	2.34	2.37	2.29	2.99	2.52	2.50	0	0	.79	.93	.32	.41
Oct. 1-31	3.81	1.30	1.26	2.17	2.80	1.45	1.80	0	0	1.20	1.30	.22	.54
Nov. 1-30	2.58	1.06	1.06	2.48	2.19	1.36	1.63	.24	.23	1.51	1.81	.88	.93
Dec. 1-31	8.69	3.31	3.11	8.08	7.52	4.03	5.21	2.55	2.12	7.93	6.81	3.11	4.50
Totals	32.69	18.20	17.27	25.23	27.55	19.95	21.65	5.73	5.19	15.51	16.00	8.08	10.10

Lysimeter No. / Condition	Precipitation Inches	Evaporation loss in inches (Infiltration less percolation) 1 Bare	2 Bare	3 Litter	4 Litter	7 Bare	Average	Average evaporation as percent of infiltration	Evaporation from a free water surface in inches
Periods									
Jan. 1-Feb. 10	4.51	.72	.81	.74	.57	.66	.70	19.6	2.78
Feb. 11-Mar. 31	1.12	.67	.66	.70	.60	.52	.63	56.2	7.08
Apr. 1-May 31	1.49	1.21	1.19	1.06	1.11	1.11	1.14	91.2	15.48
June 1-July 15	.48	.47	.46	.48	.48	.48	.47	100.0	16.29
July 16-31	2.13	1.84	1.48	1.54	1.89	1.67	1.68	99.4	5.66
Aug. 1-31	4.65	2.34	2.03	1.61	2.25	2.60	2.17	90.4	8.45
Sept. 1-30	3.23	2.34	2.37	1.50	2.06	2.20	2.09	83.6	6.59
Oct. 1-31	3.81	1.30	1.26	.97	1.50	1.23	1.25	69.4	5.12
Nov. 1-30	2.58	.82	.83	.97	.38	.48	.70	42.9	2.67
Dec. 1-31	8.69	.76	.99	.15	.71	.92	.71	13.6	2.24
Totals	32.69	12.47	12.08	9.72	11.55	11.87	11.54	53.3	72.36

almost directly proportional to the amount of water infiltrating into the soil. The occurrence of percolation on litter covered plots in August and the fact that total amount of evaporation was slightly lower on litter covered plots indicate that a covering of oak litter retards evaporation. Under field conditions, shading would lower evaporation still more but transpiration from trees and ground cover would, of course, offset this gain.

Data given in table 1 also show less infiltration per unit of area on the smaller 500-square-inch plots than on the 1,000-square-inch areas, indicating that size of area influences infiltration and that the smaller the plot the less the infiltration in surface inches, other conditions being equal. This information checks with data at other lysimeter and run-off stations on the Sierra Ancha Experimental Forest and with findings of other workers in the influences field.

Although data on run-off, infiltration, and percolation from soil blocks of uniform character cannot be translated directly into terms of inches of yield from a watershed where many diverse conditions obtain, results do aid in the interpretation of water behavior and utilization. They show a very high water loss from soils supporting no vegetation. Practically all of the summer rainfall and a high percentage of spring and fall precipitation evaporates. Percolation or seepage flow is shown to be much greater on litter covered areas than on bare areas. Most of the water is yielded via the underground route, and soil erosion is negligible. On bare areas yield is largely via the surface route and loss of topsoil by erosion is much greater. The significance of these findings lies in the fact that underground delivery results in lower flood peaks, much less silt, and a higher quality of water.

STABILIZATION OF SOILS

Southern

Roadbank-Fixation Plan for the Holly Springs National Forest. The Station's forest-influences division within recent months has completed a Project Plan for roadbank stabilization and associated erosion-control work on the Holly Springs National Forest. This is a detailed operations plan showing the specific location of each road-erosion control problem on 75 miles of Forest Service roads, the stabilization measures required to correct each, detailed cost estimates, and much additional information with regard to performing the work and maintaining the control measures. The plan is based on a very detailed survey of all Forest Service roads and the use of roadbank-stabilization techniques that have been developed in research trials at Holly Springs during the past 4 years.

Although the Holly Springs plan calls for corrective measures on backslopes, fills, road berms, roadside and lead-out ditches, and all contiguous eroding areas which contribute to or are damaged by road drainage, the major problem, and the key to other work, centers around the revegetation of the raw, eroding cutbanks. The survey shows that on the 75 miles of Forest Service roads on this unit, there is an aggregate area of almost 2 million square feet of eroding backslopes in need of corrective measures, not to mention a considerable but much smaller area of road fills and berms requiring similar treatment.

In all, seven stabilization treatments are prescribed in the Holly Springs plan. Two of these involve simple mulching treatments, whereas the other five involve seeding or sodding of certain plant materials subsequent to site-improvement measures. The mulching treatments consist of applications of wild hay or brush-litter mulches on graded and scarified, but otherwise untreated, backslopes. The five treatments entailing use of plant materials provide for the broadcast-seeding of Korean lespedeza, common lespedeza, or Bermuda grass, or the application of two types of Bermuda grass sod material. The backslopes in all instances are first reduced to a 1:1 or 1½:1 gradient, suitably scarified with picks or mattocks to provide a loose surface, given a uniform dressing of topsoil to a depth of about 3 inches, and fertilized at the rate of 2 pounds per hundred square feet with a specially compounded 6-8-6 fertilizer. These treatments are prescribed mainly on the basis of a growth-site classification developed in the Holly Springs studies which utilizes such criteria as soil color, texture, moisture and temperature relations, etc., in classifying roadbanks as adverse, moderately favorable, or relatively good for plant growth.

Total cost of the program on the Holly Springs National Forest is estimated at $42,402, or an average of $562 per mile. Eighty-four percent of the total cost is a labor charge, and the entire program can be accomplished under the CCC program with a total nonlabor cash outlay of less than $7,000. One CCC camp working only part-time can perform all of the prescribed work in from 1 to 2 years. The program involves the sowing of 1,270 pounds of Bermuda grass seed and 732 pounds of Korean and common lespedeza seed; the use of 423 truckloads of sod materials and 19 tons of fertilizer; the planting of 73,000 pine seedlings; and the application of large quantities of topsoil. Work will start early in 1941.

Revision of Erosion-Control Planting Standards. The Station recently assisted the Administrative Branch in revising the erosion-control standards for the Holly Springs National Forest. The original standards were prepared by Meginnis in 1935, but during the past few years, methods actually used in reforesting eroding lands on this unit have tended to deviate from Station recommendations, and needed to be brought up to date. The Station's gully-control plantings at Holly

Springs, some of which were put in as early as 1931, are now far enough along to demonstrate the soundness of many of the Station's past recommendations and serve very effectively to illustrate the efficacy of rather simple reforestation measures in controlling gully erosion. After a field meeting of several days, the planting plan was completely revised and now embodies the Station's latest recommendations. Features of the revised plan may be briefly stated as follows:

First priority in the erosion-control planting program will be gullied or sheet-eroded old fields. Second priority will be old-field areas which have lost all or most of the original topsoil but now support a fairly complete cover of grass or herbaceous plants. Planting of all reasonably productive fields, that is, those located on stream bottoms or terrace lands, will be deferred indefinitely, since these may have agricultural value and hence should be reserved until such time as it is determined whether they have usefulness in rounding out self-sustaining farm units within the forest boundary. The latter principle is in harmony with the Service policy of rehabilitating or considering the need of local people in connection with Acquisition and other forest programs and will restrict tree planting on the relatively few sites in the locality that are very productive from a forestry standpoint.

No check dams or other site-improvement structures will be established on eroding or gullied areas until such time as the need for them is definitely established; that is to say, all plantable sites will, under the revised plan, be planted to trees, employing spot-planting methods which utilize only those sites that are plantable or on which the trees can readily become established. A follow-up survey will reveal whether failures or excessively large blank areas are such as to require establishment of such check dams, soil-collecting trenches, etc. Decision as to the need for structures will be vested in a competent technician who, at the end of the first or second growing season, will examine all planted areas, prescribe the type of structure that is needed, and stake out the location of each. This new approach represents a progressive step; it will tend to correct previous errors by utilizing site-improvement measures more sparingly than in the past and will put the emphasis on forestation techniques rather than dam-building and other site-improvement treatments.

In the future, no black locust trees will be planted. Loblolly pine will be the preferred species on all eroded areas, although the use of shortleaf pine is optional. Shortleaf pine will be planted exclusively on all second-priority areas. Strictly grade 1 trees will be planted on eroded old fields, with the use of grade 2 seedlings somewhat optional on certain sites.

Variations in site quality and adaptations will be given more recognition and will be emphasized in training planting crews to properly recognize these variations. Representative planting sites have been described and classified and a number of nonplantable sites have been specified with a view to eliminating a certain amount of useless planting operations that have been practiced in the past.

The simple type of pole-frame brush dam as described in the Station's Occasional Paper 76 was adopted as a substitute for the heavy-duty types of brush and log dams previously employed. Wire sod dams will, however, be employed where there is insufficient material for the poleframe brush structures. Soil-collecting trenches of the type prescribed by the Southern Station will be used where applicable. In planting certain adverse eroded areas, the hole-topsoil method, employed successfully in early Holly Springs studies, will be used.

RANGE RESEARCH

ARTIFICIAL REVEGETATION

Intermountain

Methods

Garden Tractor Adapted for Work on Artificial Reseeding Plots. Problems peculiar to research in artificial revegetation constantly necessitate the development or adaptation of machinery for special uses. Sidehill drills for seeding steep slopes and hand devices for collecting and cleaning seed of native species have been already described and have been much used. The search for machinery to use in special phases of artificial revegetation investigations continues. During the past field season two 1-hp. garden tractors have been used successfully under a variety of conditions for weeding, cultivation, and seeding of intensive experimental plots.

A great advantage of the tractor is that it can be handled by one man, and, without dismantling, is easily transported in a pick-up truck or panel delivery sedan. In out-of-the-way places where horses are not readily available the tractor has solved the problem of power for cultivation and seeding experimental plots. In addition, a nicety of control, so important in working small plots, is permitted to a much greater degree with the tractor than with a horse.

The original tractor frame was modified to accommodate all implements used in cultivation. Tools successfully used to date include: disks, duckfeet (sweeps), knives (hoes), furrowers (shovels), cultivator teeth and diggers (chisel teeth). These tools, in various

combinations, have been used under all conditions encountered during the past field season. The possible tool combinations are so flexible that any new conditions incident to cultivation or seeding can undoubtedly be met by further adaptation of these or other tools.

The drilling attachment was so made that small intensive plots of 1/200-acre as well as range plots of 1/10-acre could be quickly and successfully seeded. An iron shank clamped to the tractor tool frame holds the Planet Jr. seeder unit upright above the frame at any height or in any position. The seeder agitator is driven by a chain sprocketed to the tractor axle.

Two regular 12-inch drill disks are clamped to the tractor tool frame, and by adjusting clamps along the tool frame, row spacing may be varied from 3 to 36 inches and the pitch of the disks altered. The flexible seed tubes are attached to the boot of the disk in such a manner that the falling seed is visible.

Since the seeder unit had adjustments for 34 rates of seeding, it is possible to seed most species at a comparatively accurate rate. Additional larger openings have been made to facilitate seeding light or large-seeded species. Seed which is very chaffy or possesses long appendages may be successfully seeded only when cleaned or de-awned before seeding. It is possible that a supplementary agitator may help solve the problem of seeding chaffy or awned seed.

A wheel attached to the tractor tool frame may be clamped at any height to adjust the depth of seeding. Drill disks have successfully cut down to $2\frac{1}{2}$ inches through dry grass and weeds under range conditions and through the dense sod formed by the fall growth of Bromus tectorum, or other fall-growing species. This modified tractor-drill has been successfully used in fairly dense stands of Artemisia tripartita, A. tridentata, and Chrysothamnus spp. averaging up to 18 in height.

While this tractor drill was designed for seeding experimental plots, at the same time it simulates large-scale drilling. On steep slopes the tractor drill has not been successful but it is expected that further modifications may extend its use at least to moderate slopes.

Trials in the fall of 1940 with 60 species and several mixtures on more than 1,000 plots at 11 locations and under various conditions show the tractor-drill to be a practical machine for seeding on a plot basis. In one hour, 15 to 30 1/200-acre range plots with rows spaced 12 inches apart and involving a variety of species may be seeded. Conditions that influence the speed of seeding are the character and purity of the seed, the number of species being sown on each area, the physical nature of the site, and the size of plots.

Species

Effect of Low Temperature on Germination of Native Forage Species. A number of investigators have established the fact that seeds of many species require a period of moist cold storage before they will germinate satisfactorily.

In routine germination tests, where seeds of more than 300 species collected for experimental plantings were subjected to alternating temperatures of 30° C. for 6 hours and 20° C. for 18 hours, and room temperatures of 20 to 25° C., the percentage germination of many species was low.

To determine suitable methods of inducing satisfactory germination several treatments are made. The following table shows the germination obtained from a 15-weeks' period in moist cold storage at 3 to 5° C. followed by 5 weeks in the germinator at 28° C. Subjection of seed of these same lots to alternating temperatures (6 hours at 20° C. and 18 hours at 30° C.) and room temperature (20 to 25° C.) for as long as 16 weeks produced percentages usually below 5 percent. It is interesting to note that germination of many species takes place while the seed is still in cold storage. The following species: Aconogonum phytolacaefolium, Balsamorhiza sagittata, Helianthella uniflora, Melica bulbosa, and Purshia tridentata germinated practically to capacity during the cold storage period. Evidence indicates that additional germination may be obtained from many other species by longer cold storage treatment. While freezing and thawing treatments increased germination of many species over that obtained by alternating temperatures, it did not give as high a percentage germination as that resulting from 16 weeks cold storage for any species. Planting outside in January, thereby subjecting seed to the fluctuating temperatures of the winter and early spring months caused many species to show a higher germination than when alternating temperatures were used. However, no significantly higher germination was obtained by this method than from cold storage treatment.

Seeds germinating outside are subject to uncontrolled freezing, drying, and fungous infection, and for this reason it is naturally expected that germination outside would not be as high as in the laboratory where these hazards may be controlled.

The working out of practical methods of overcoming difficulties presented by the refractory germination of otherwise very desirable plants for use in artificial reseeding is an important field of research that is being investigated by the artificial revegetation project.

Table 1.--Percent germination obtained from 16 weeks cold storage followed by 5 weeks in the germinator.

Species	Alternating temperatures	Cold storage
Aconogonum phytolacaefolium	0	93
Amelanchier alnifolia	0	97
Balsamorhiza sagittata	0	90
Cercocarpus ledifolius	0	71
Eriogonum heracleoides	3	57
" umbellatum	5	76
Grayia spinosa	22	68
Helinathellia uniflora	2	91
Leptotaenia multifida	0	79
Melica bulbosa	2	98
Osmorrhiza occidentalis	0	75
Purshia tridentata	0	100
Stipa lettermani	20	100

Northern Rocky Mountain

Methods

Reseeding on Cutover Land. During the fall and winter of 1938-39, the Cabinet National Forest cleared, with CCC labor, most of the second-growth lodgepole and ponderosa pine from the Thompson Falls Administrative Site. Since the area was logged about 35-40 years ago and burned over in 1910, an open pole stand had become established on most of the area, but a grassland type occupied portions of it. Density of low vegetation on this type average 0.30 but under the second-growth the density was about 0.25. Precipitation averages about 20 inches, elevation of this valley bench is about 2,500 feet, and the soil is sandy loam of good depth.

Clearing was done primarily to improve pasturage for pack stock. With some advice and help from this office, certain plots within the cutover type were reseeded to different forage species and mixtures under two degrees of soil preparation and three other plots within the grassland type were reseeded after being double harrowed, plowed, and disked three or more times, respectively. The disk used was light and did not disturb the roots very thoroughly. Following are some preliminary results based on an examination made in July 1940:

Cutover Stumpland. 1. Without soil preparation—A mixture including crested wheatgrass, Timothy, orchardgrass, tall oatgrass was broadcast-seeded in December 1938 on about 4 acres among stumps where soil had been somewhat disturbed by cutting and skidding of poles and where the density of low vegetation averaged about 0.15. Results in July 1940 were practically a failure. However, a good stand resulted from a somewhat similar test on the Bitterroot in 1940 where competition from existing vegetation was less severe.

2. Burned spots on cutover stumpland type where brush piles had been burned—A mixture of the above species with mountain brome grass added was seeded in December 1938 and raked in by CCC boys with garden rakes. Results: Crested wheatgrass, Timothy and orchardgrass plants were well established and vigorous on these burned spots but only a few mountain brome and tall oatgrass plants survived. Survival was better near the edge where ashes were thin than near the center of burned spots where ashes were thick.

On the Intermingled Grassland Type. There the original stand of native vegetation averaged about 0.3 density, one plot was double harrowed, another disked three or more times, and the third plowed and double disked early in the spring of 1939. One-quarter of each of these three plots was seeded in early April 1939 with crested wheatgrass, smooth brome, tall oatgrass, and Ladak alfalfa and harrowed to cover the seed. Double harrowing failed to do much damage to existing vegetation and the competition was so severe that none of the four species seeded made any showing.

On plots that had been disked only, 25 percent or less of the total vegetation last July was crested wheatgrass or smooth bromegrass, with the former making a better showing than the latter. Crested wheatgrass made up about 60 percent of the total vegetation that averaged about 0.40 density, and on portions of the plowed plots where these species were seeded, despite the very loose seedbed smooth brome made up 45 percent of the total cover. Even though the reseeded species may eventually form a complete stand on plots that were disked only or plowed and double disked, the expense of such treatment is seldom, if ever, justified. No Ladak alfalfa and only a few tall oatgrass seedlings were found on any of these plots.

From the foregoing tests and others made on the Bitterroot and elsewhere, it seems evident that competition is a major handicap in reseeding such cutover lands. Control of competition by methods that are within cost limitations is clearly one of the important problems of reseeding such areas. The persistence of the species that were successfully established is yet to be determined on these tests. Survival may also prove to be greater in future than was evident last July.

GRAZING MANAGEMENT

Appalachian

Grazing Capacity. The approximate grazing capacity of three reed pastures at the Wenona Station in the Coastal Plain in North Carolina, utilized at different seasons, has been determined for the years 1934-40, inclusive. Figures on the number and class of animals in each of the pastures for these years were obtained from the North Carolina State College.

In figuring cow-days of grazing, a calf was considered as one-half animal unit and a yearling as three-fourths unit. The grazing capacity here is judged to be considerably above the average over the Coastal Plain section according to observations made in connection with a recent survey.

A pasture of 73 acres was grazed during two periods each year, from about May 15 to August 1, and again from approximately October 1 to November 15, a total of 123 days. During this time the pasture was stocked at the average rate of one animal per acre. The pasture furnished 114 cow-days of grazing per acre last year, and at the end of the season, it was very closely utilized. Judging from the large number of dead reeds and the low vigor of many others, this pasture must have been considerably overstocked in previous years. A reduction in the grazing capacity also indicates overgrazing; the pasture furnished 24 percent less grazing last summer than during the previous year, and 31 percent less than it did in 1935. Of course, some of this change in forage production may have been due to weather.

Another pasture, of 80 acres, was grazed approximately 61 days each year, from about August 1 to October 1. During this period it was stocked at the rate one animal per 0.91 acres. In 1940 it furnished 60 cow days of grazing per acre, and it averaged 67 days per acre for the seven years. The reeds in this pasture were about moderately utilized last season. They do not show as much damage from heavy use in previous years as do those in the 73-acre pasture.

A 32-acre pasture was grazed for about 119 days each year, from about May 10 to September 5. During this time it was grazed at the rate one animal per 1.9 acres. This pasture furnished 77 cow-days of grazing last summer and showed heavy utilization at the end of the season. During the 7 years it furnished an average of 61 cow-days of grazing per acre, and the condition of the reeds indicates moderate use in previous years.

Usually the cattle were in some of these three pastures from about May 15 to November 15 each year, a total of 184 days.

During this time the pastures combined furnished an average of 88 cow-days per acre each year. Together they were stocked at the rate of one cow per 2.1 acres during the 184-day period. This rate of stocking was a little too heavy since the reeds are now in a weakened condition from overgrazing. Perhaps one cow per two and one-half or three acres of reeds for the period May 15 to November 15 are the least one can plan on and still maintain the satisfactory pasture conditions.

Intermountain

Winter Ranges

Factors Influencing Plant Density and Herbage Yields. Repeated efforts have been made by range investigators to determine the influence of certain factors of climate on plant growth. The greatest attention has been directed toward the correlation of rainfall for a year or parts of a year with the herbage yield. Where such studies are confined to an individual species, precipitation or other climatic factors may correlate fairly well with plant responses. However, when such studies are applied to a complex plant type similar to those encountered in range work, the problem becomes extremely complicated, and the plant responses measured in aggregate by total herbage yield are difficult to evaluate or segregate in terms of causal stimuli.

The Desert Branch Station is apparently situated on the border between two climatic regions. In some years precipitation may occur primarily during the winter and early spring from storms which cross northern Utah. In other years most of the precipitation may come during the summers from storms which originate to the south or southwest. At occasional intervals, the vicinity of the Desert Station receives a combination of both the northern and southern storms as in 1938 when precipitation was above average and well distributed throughout the year. Likewise at intervals the area may receive very little precipitation from either source as was the case in 1934. The fluctuation in total precipitation and the season at which it occurs, markedly influences forage production. Seasons with good winter, spring, and fall rains seem to favor the growth of shrubs, winterfat (Eurotia lanata), shadscale (Atriplex confertifolia), rabbitbrush (Chrysothamnus stenophyllus), black sage (Artemisia nova), and Indian ricegrass (Oryzopsis hymenoides). On the other hand seasons with heavy summer rains apparently favor a prairie or plains type of vegetation characterized by summer-growing grasses, such as grama grass (Bouteloua gracilis), galleta grass (Hilaria jamesii), and dropseed (Sporobolus cryptandrus), and also the summer-growing annuals such as annual Bouteloua barbata, Munroa squarrosa, Triodia spp., pepperweed (Lepidium scopulorum), and the exotic and prolific

Russian-thistle (Salsola pestifer). The fluctuation of the two types of weather conditions produces a climate which tends to maintain an equilibrium between shallow and deep-rooted vegetation. If either form of rainfall were to persist over a period of time, a major transformation in vegetation would probably result.

Plant densities, presented in table 1, under three intensities of grazing show wide fluctuations between years, species, and intensities of use. Total plant cover in 1936 increased on the moderately and lightly grazed areas as compared to 1935. Grasses, particularly dropseed, showed the greater increase. During the same period shadscale declined but winterfat increased slightly. On heavily grazed range there was a decline in most species, most marked in galleta grass, shadscale, and winterfat. Under heavy use a few species low in palatability such as blue grama grass, dropseed, and three-awned showed some increase.

March, July, August, and October had heavy precipitation, with 2.98 inches coming in July. This apparently was more favorable for grass production than for shrub growth.

Differential decreases in plant densities at the Desert Station following the unprecedented dry summer of 1940 tended to level off the differences in plant cover between areas subjected to three different intensities of use. On areas where plant cover already had been reduced by three years of heavy grazing the decrease in plant density between 1938 and 1940 was only 25 percent, while on areas where the plant cover had improved under moderate and light grazing the decreases were 29 and 45 percent, respectively. Densities for individual plant species fluctuate widely but tend to show greater decrease during drought on moderately and lightly grazed ranges where the cover was near a maximum. For example, galleta grass decreased only 16 percent on the partially depleted heavily grazed area and 58 percent on the lightly grazed range where the density of this particular species was greatest in 1938. Winterfat decreased 18, 33, and 29 percent, respectively, on heavily, moderately, and lightly grazed areas. The resultant total density for the three areas are more nearly the same than during years of greater precipitation and more favorable growing conditions.

Data indicate that under severe drought conditions only a certain total cover can be maintained, which is determined primarily by the amount of effective precipitation. On ranges where the existing plant cover and vigor is already reduced by heavy grazing to the survival level of a given drought year, little additional decrease would be likely to occur. However, on areas where plant cover far exceeded the survival level of a given drought period, a substantial decrease would probably result. Plant cover in excess of that which could be maintained by the precipitation would die or as with some species remain dormant until favorable climatic conditions were restored.

Table 1.--Plant densities recorded in percentage of ground covered for three intensities of grazing at the Desert Branch Station. (Data taken by square-foot-density method.)

	1935	1936	1938	1940	*	1935	1936	1938	1940	*	1935	1936	1938	1940	*
	Heavily Grazed					Moderately Grazed					Lightly Grazed				
Three-awn	.012	.014	.011	.011	100	.025	.027	.024	.016	67	.033	.037	.068	.038	56
Blue grama	.033	.261	.243	.121	50	.141	.188	.192	.158	82	.189	.231	.363	.179	48
Galleta	1.189	.661	.682	.574	84	.743	.743	.755	.683	91	.762	.769	1.077	.449	42
Indian ricegrass	.074	.056	.056	.066	118	.065	.082	.130	.120	92	.072	.076	.095	.084	88
Sand dropseed	.340	.449	.431	.333	77	.576	1.028	.873	.654	75	.633	.880	1.116	.775	69
Spike "	-	.004	.001	.002	200	.016	.040	.048	-	-	-	.017	.029	.006	21
Mallow	.101	.168	.131	.067	51	.057	.175	.156	.093	60	.066	.158	.142	.024	17
Russian-thistle	.001	.006	.006	-	-	-	.001	.002	-	-	T	.010	.022	T	-
Budsage	.137	.214	.175	.134	77	.066	.192	.114	.096	84	.031	.078	.061	.024	39
Shadscale	1.591	.918	1.074	.593	55	1.149	.883	.774	.356	46	1.108	.852	1.064	.539	50
Winterfat	.872	.669	.605	.496	82	.616	.700	.652	.439	67	.685	.728	.792	.563	71
Little rabbitbrush	-	.015	.001	-	-	.004	.005	.014	.004	29	-	.020	.022	.017	77
Rabbitbrush	.063	.035	.012	.002	17	.017	.004	.001	-	-	.062	.018	.027	.037	137
Snakeweed	.025	.026	.046	.036	78	.004	.009	.012	.004	33	.016	.023	.133	.010	8
Mormon tea	.279	.111	.075	.075	100	.106	.101	.094	.112	119	.097	.071	.054	.043	80
Totals	5.017	3.607	3.374	2.510	75	3.585	4.178	3.841	2.735	71	3.754	3.968	5.065	2.788	55

* Denotes 1940 densities in percent of the 1938.

Because of decreased plant vigor on the heavily grazed ranges forage production by weight gave nearly opposite to those obtained in terms of plant density. Comparison of forage yield for the same areas shows forage production by weight in 1940 to be 56, 40, and 51 percent, and density 25, 29, and 45 percent below the 1938 level on the heavily, moderately, and lightly grazed paddocks. Thus a 25 percent decrease in density on the heavily grazed area was accompanied by 56 percent decrease in total forage yield while on moderately grazed range a density decrease of 29 percent was associated with only 40 percent decrease in total herbage production. Plant responses measured in terms of total herbage differ with species, grazing treatment, and no doubt with period of rainfall.

In summary, the above preliminary analysis of climate and plant growth data bring out a number of vital and important points which must be considered in evaluating climatic influences in terms of ranges, plant types, or individual plant species.

1. Climatic influences are extremely complex and produced varied and differential responses in different range plants.

2. Fluctuations in total and seasonal precipitation present a problem which makes it difficult to compare and evaluate forage yields between years or localities.

3. Drought apparently "levels off" differences in plant cover. A given amount of effective rainfall will apparently support only a certain amount of total vegetation. All cover in excess of the survival level remains dormant until a more favorable year. Thus, range bearing the greatest amount of plant cover apparently suffers most on a percentage basis during drought periods, but still greatly outyields heavily used range.

4. Plant cover or density is not necessarily a measure of forage production. Plants in good vigor produce more per unit of density than do weakened or poor ones.

Spring-Fall Ranges

Cured Range Grass and Weed Herbage of Low Value for Sheep. The value of cured herbage of bluebunch wheatgrass (Agropyron spicatum), or range mixtures in which bluebunch wheatgrass makes up bulk of the mixture, for sheep feed during fall and winter periods is open to serious question. McCall, in studying such feeds (Jour. Agr. Res. 60:39-50) found crude protein and crude fat content were extremely low with the result that maintenance requirements of range lambs were met in only one of three years by range forage.

The chemical composition data obtained by McCall who worked in the Palouse region of Washington, have been duplicated at the U.S. Sheep Experiment Station. "Well cured" fall herbage of bluebunch wheatgrass had a crude protein, crude fat, and crude fiber content of 3.0, 1.4, and 28.0 percent, respectively. If the digestibility of herbage at the U.S. Sheep Experiment Station is no greater than that found by McCall, and there is little reason to believe that it is, such forage is not rich enough in nutrient material to meet the maintenance requirements of range sheep. Especially is this true in the case of phosphorus, for even though all the phosphorus content of 0.03 percent were digestible, which is extremely unlikely, a sheep could not consume sufficient quantity of herbage to satisfy its maintenance requirement for phosphorus. Hence a seasonal phosphorus deficiency is likely to occur.

These data, and McCall's, summarized in the following table, indicate that bluebunch wheatgrass may have been overrated as fall feed for sheep.

Chemical composition of bluebunch wheatgrass and range mixtures

Species	Location of collection	Year	Ash	Crude protein	Crude fiber	N-free extract	Crude fat
Wheatgrass	McCall	1930	10.14	2.94	33.37	39.61	2.68
Range-mix.	"	1930	7.96	3.73	29.36	43.54	3.47
" "	"	1932	12.88	2.46	31.76	38.90	4.78
" "	"	1933	6.72	2.18	35.75	41.78	1.66
Wheatgrass	USSES	1937	11.38	3.17	29.30	44.79	1.35
"	"	1939	10.35	2.61	27.99	47.65	1.40

Species	Location of collection	Year	Calcium	Phosphorus	Ca/P ratio
Wheatgrass	USSES	1937	0.39	0.035	11.1
"	"	1939	0.34	0.030	11.3

Northern Rocky Mountain

Short Grass Ranges

Density and Weather Variations. The more or less common assumption that native grasses of the Great Plains are able to withstand drought without serious effects is severely jolted by quadrat records on experimental pastures at Miles City charted annually since 1933. Remarkable variations in density have occurred in close relation to weather, particularly moisture.

Total precipitation for 1940 was slightly above normal for the first time since 1932. Seasonal distribution was favorable for continued recovery from effects of drought in 1934, 1936, and early 1937. Total density on 52 meter-square quadrats had increased by June 1940 by approximately 80 percent over 1939, was six-fold greater than in 1937 but still 42 percent below the 1933 level. Blue grama and buffalo grass both doubled in density over 1939 while bluestem and niggerwool sedge increased 36 and 11 percent, respectively. Sandberg bluegrass, which reached its greatest density early in 1938, continued to run contrary to other species by a substantial decline in 1940 as compared to the previous year. However, it is still twice as thick as in 1933 before the drought years. For total vegetal density trends appeared to be upward after chartings last June and it is anticipated that by early 1941 the total will be very near the predrought level. Height and volume growth have been above normal during the past three favorable seasons which has partially made up for density deficits since the drought years.

Range Survey of Experimental Pastures. In an effort to show vegetal trends by an extensive method to supplement data from intensive methods generally employed in range research, range surveys were made during the summer of 1940 of the summer and winter experimental cattle pastures at Miles City. The original surveys of these areas were made in 1933 by the reconnaissance grid method while the 1940 surveys were done on aerial photographs taken at an elevation of about 5,000 feet. Much more detail in "typing" was possible on the photographs. A comparison of the forage acres resulting from the two surveys made 7 years apart is shown in table 1 by grazing intensities. Changes in forage acres are shown by the percent the 1940 values are of the 1933 values.

Table 1.--Forage acres by grazing intensities, 1933 and 1940 surveys.

LONE PINE WINTER PASTURES				HOGBACK SUMMER PASTURES			
Intensities	Forage acres		1940 / 1933 percent	Intensities	Forage acres		1940 / 1933 percent
	1933	1940			1933	1940	
Q&T Heavy	57.05	37.92	66.47	A&E Heavy	56.73	31.35	55.3
S&U Moderate	79.85	54.89	68.74	C&D Moderate	81.62	50.16	61.5
R&V Light	103.82	59.40	57.21	B&F Light	97.01	58.65	60.5
Total	240.72	152.21	63.23	Total	235.36	140.16	59.55

That there has been a general decrease in forage density in all pastures was known from quadrat and other detailed records and this was reflected by results of this survey. This decrease is largely due to the drought years, particularly 1934 and 1936. However, it may also be partially due to a shifting of range survey standards of estimating density, etc., toward the conservative side. Close examination of the data shows no marked differences in the reduction in forage acres between three grazing intensities. A similar conclusion has been drawn from other data bearing on this point which also shows a strong uptrend in density as noted above.

Rocky Mountain

Ponderosa Pine Ranges

Grazing Experiment to Start in 1941. Fencing and water developments have been completed on six experimental pastures of approximately 300 acres each on the Manitou Experimental Forest near Woodland Park, Colorado. A corral for sorting and weighing cattle was installed recently. The working plan for studies of effects of grazing on beef gains, vegetation, erosion and infiltration is in the final stage of preparation, having been written jointly by the divisions of forest influences and range research.

One innovation in the design of the study is a reference grid in each pasture, consisting of points marked by permanent stakes, which will enable the field examiner to locate himself when using randomized plots. Clipped plots for determining forage utilization and forage production, infiltration studies and other periodical observations will be randomized within vegetation types and within blocks in the various pastures to facilitate analysis of the data.

Three intensities of grazing, duplicated, will be used in the cattle phase of the study. Yearling Herefords will be furnished for the experiment by local ranchers, beginning June 1, 1941.

Short-grass Ranges

Stocking Rates on Short-grass Ranges. Weight gains of yearling Herefords for the period, May 1 to October 30, 1940, on the Central Plains Experimental Range recently have been compiled. Animals grazed at the heavy rate (15 to 20 surface acres per animal) gained 254.3 pounds each during the grazing season. In conservatively stocked pastures (25 to 30 acres per animal) individual gains averaged 302.8 pounds. Restricted stocking (35 to 40 acres per animal) resulted in average gains of 328.2 pounds.

In this first year of the experiment total pounds of beef produced was greatest in the heavily grazed pastures. The difference in pounds of gain, however, was not proportional to the reduction in livestock numbers in the lighter stocked pastures. Although the conservative rate of stocking represented a 20 percent reduction under the heavy rate it resulted in only 4.7 percent reduction in the total number of pounds produced. The restricted rate produced the highest individual animal gains but the 40 percent reduction in numbers offset the total pounds produced to the extent that this rate did not compare favorably even with conservative stocking.

Evidence from similar pastures which have been stocked at the heavy rate for two years indicates that the second year of grazing results in damage to the vegetation to the extent that the greatest total gains will be obtained under conservative grazing.

Indications of the effects of grazing on vegetation under the three rates of stocking may be obtained from the following data for blue grama and buffalograss, obtained at the end of the grazing season in 1940.

Rate of stocking	Reserve forage (grams per plot)	Percentage utilization (per pasture)
Heavy	20.3	80
Conservative	27.6	69
Restricted	42.2	58

Southwestern

Yearlong Ranges

Mixed-Grass Range. Measurements were made during 1940 to determine differences in vegetational composition between a cattle-excluded plot fenced in 1916 and the adjacent grazed range. As no outside plot was established in 1916, a comparable grazed plot of the same size as the inside plot (50x75 feet) was selected on the basis of similarity of soil, slope, and exposure. As the range area was reasonably uniform and similar in all respects to the protected plot except for vegetational composition, it is believed the plot selected was representative of average conditions and that differences in vegetation noted were due to differences in grazing use rather than any inequalities in basic habitat conditions. The outside area had been moderately to heavily grazed during most of the 24-year period.

The paired plots were sampled by the line interception method using twenty-five 50-foot lines. The measurements obtained for grasses are shown in table 1.

Table 1.--Summary of two plots showing density and composition of perennial grasses on each as sampled with twenty-five 50-foot linear sampling units.

Perennial grasses	Protected Plot			Grazed Plot		
	Vegetation ± standard error	Density ground cover	Composition	Vegetation ± standard error	Density ground cover	Composition
	Mean Ft.	Pct.	Pct.	Mean Ft.	Pct.	Pct.
Aristida divaricata	.4924±.094	.9848	26.47	.3192±.0332	.6384	33.33
Andropogon saccharoides				.0144±.0125	.0288	1.50
Bouteloua eriopoda	.1556±.041	.3112	8.37	.2020±.0374	.4040	21.10
Bouteloua filiformis	.0392±.02	.0784	2.11	.3948±.0423	.7896	41.23
Bouteloua Rothrockii				.0104±.0047	.0208	1.09
Heteropogon contortus	.0624±.0228	.1248	3.35			
Pappophorum Wrightii				.0048±.0034	.0096	0.50
Trichachne californica	1.1104±.1721	2.2208	59.70	.0120±0069	.0240	1.25
	1.8600±.1309	3.7200	100.00	.9576±.0552	1.9152	100.00

The most important differences noted between the grazed and ungrazed plots are as follows:

1. The total density of grasses on the ungrazed plot was about twice that of the grazed plot.

2. All of the larger bunchgrasses, with the exception of Andropogon saccharoides, had a greater density under protection than under grazing.

3. The density of the three species of Bouteloua was greater under grazing than under protection.

4. Three species; namely, Andropogon saccharoides, Bouteloua Rothrockii, and Pappophorum Wrightii, were absent from the protected plot, while Heteropogon contortus was absent from the grazed plot. With the exception of the last named, the densities involved are so low that the differences are of doubtful significance.

5. The density of Trichachne californica was approximately 10 times greater on the protected plot than on the grazed plot, and the density of this species alone on the protected plot was greater than the total density of all grasses on the grazed plot.

6. The density of Bouteloua filiformis was seven times greater under grazing than on the protected plot, representing 41.23 percent of the total density on the grazed plot as against 2.11 percent of the density under protection.

7. Bouteloua eriopoda showed very little difference in density on the two plots. Data from other studies indicate that in neither case did it represent its maximum development for this area.

Based on these differences, the following conclusions might be drawn:

1. As the plots were very similar except for grazing treatment, it may be concluded that the differences represent response to protection from grazing and to a degree of use on the heavy side.

2. Under such conditions it appears that greater total densities prevail under protection.

3. Protection favors the bunchgrasses in competition while grazing favors the smaller grasses.

4. Data from this and other studies indicate that the vegetation on the protected plot represents a higher successional stage than that on the grazed plots.

5. According to the Inter-Agency palatability list, the average palatability of the vegetation on the grazed plot is slightly higher than that on the protected plot, but as the density of the latter is approximately twice as great, it has the higher grazing capacity of the two.

6. These results representing vegetational conditions in 1 year based on measurements of one pair of plots cannot be taken as conclusive evidence, but they do indicate vegetational trends under grazing use and non-use and may serve as a guide to management of the range.

Noxious Plant Control

Burroweed. Numerous investigators have indicated that a substantial decrease in the perennial grass cover occurs when this type is invaded by noxious plants such as burroweed (Aplopappus fruticosus) or velvet mesquite (Prosopis velutina). However, there is little or no experimental evidence to indicate what the

effects would be of releasing perennial grasses from the competition offered by the presence of mesquite or burroweed, i.e., by the eradication of these plants. Inasmuch as these two plants are common associates throughout southern Arizona, an experiment was designed to yield data pertaining to this question. Prior to a consideration of data secured at the initiation of the study, a brief discussion of the experimental set-up may be of interest.

The experimental design, as laid out in July and August 1940, is a conventional 4x4 Latin square in which the treatments are as follows:

1. Check (no treatment).

2. Mesquite eradication by sodium arsenite methods..

3. Burroweed eradication by grubbing.

4. Mesquite and burroweed eradication.

Data were collected prior to and immediately following treatment. Detailed observations will be made 1 year following treatment and thereafter as deemed necessary. Data obtained consist principally of photographs from established points and information obtained from line interception transects and permanently located quadrats within each plot (200x200 feet). Data will be treated by the regular analysis of variance procedure according to the following breakdown:

Source	Degrees of Freedom
Between rows	3
Between columns	3
Treatments	3
Error	6
Totals	15

If the analysis appears to warrant it, measurements can be regarded as concomitant and analyzed by the method of covariance.

Data were obtained on the immediate effect of grubbing by charting quadrats prior to (August 1-8) and immediately following (August 16-17) this treatment. Three quadrats were located within each plot. Results are presented in the following table.

From the series of differences presented in the last column the following calculations are pertinent:

Mean difference $\bar{x}$ = -32.42 square centimeters.

Standard error mean difference $\sigma_{\bar{x}} = \pm 2.9916$ square centimeters.

$t = 2.4925$ (approaches significance at 2-percent level.)

Thus the average reduction in perennial grasses immediately following grubbing, as observed from quadrat data, amounted to about 14 percent. Perennial grasses decreased on all quadrats except 2Z, 10Y, 15X, 15-Z, and 16X. The increase on these quadrats is probably due to one or more of the following factors: Less disturbance from grubbing, more rapid vegetative growth, and error in charting.

Summary of perennial grass cover in square centimeters per square meter quadrat prior to and after grubbing.

Quadrat number	Perennial grasses prior to grubbing	Perennial grasses after grubbing	Difference
	Cm^2	Cm^2	
1X	224	158	-66
1Y	153	131	-22
1Z	157	142	-15
2X	337	215	-122
2Y	315	285	-30
2Z	236	327	91
7X	335	233	-102
7Y	385	246	-139
7Z	319	296	-23
8X	75	45	-30
8Y	152	70	-82
8Z	240	134	-106
9X	210	147	-63
9Y	196	135	-61
9Z	234	229	-5
10X	374	326	-48
10Y	312	335	23
10Z	354	263	-91
15X	207	263	56
15Y	59	45	-14
15Z	197	319	122
16X	123	142	19
16Y	117	98	-19
16Z	193	142	-51
Totals	5504	4726	-778
$\bar{x}$	229.33	196.92	-32.42

COOPERATING BUREAU PROJECTS

ENTOMOLOGY

(In cooperation with the Bureau of Entomology and Plant Quarantine)

Appalachian

Tree Injection. To compare the present copper retention with that obtained from analyses of samples from the same sections made in 1935, additional wood samples for chemical analyses were collected from sections of 1935 copper sulphate treated shortleaf pine trees.

Wood samples for making moisture determinations were collected from sections of pine and poplar trees. These trees were treated with various chemicals in 1938 and parts of them were subsequently stored under cover to obtain further data on bark retention.

Termite Control. The Division of Forest Insect Investigations held a conference at Washington, D.C. to formulate suitable specifications for the country as a whole for the protection of national defense buildings against termite attack. In connection with this, several members of the conference made an inspection trip through parts of Louisiana and Texas. The purpose of this trip was to observe termite shelter tube construction under different sites, such as is presented by buildings of varied construction; also the installation of patented termite shields, and those not patented, on such buildings as a safeguard against attack by this insect.

Bark Beetles. Each of the 15 southern pine bark beetle plots previously established this year on the Bent Creek Experimental Forest was described for future reference. These plots will provide data on the volume of timber killed by the insect and the plant succession following a bark beetle kill. Measurements of bark beetle killed pines have been completed for three of the plots.

Northeastern

European Spruce Sawfly Parasite Utilized Against Native Sawfly by T. V. A. W. F. Sellers, New Haven, Conn., reports that early in November the Division of Forest Insect Investigations supplied the State Entomologist of Tennessee and the Forestry Relations Department of the Tennessee Valley Authority with 300,000 to 400,000 of the Chalcid parasite, Microplectron fuscipennis Zett. for release in pine plantations that have been severely infested by the native LeConte's pine sawfly in the vicinity of Wilson Dam, Alabama. The

parasites were released at 30 colony sites by G. M. Bentley, State Entomologist of Tennessee, and Karl Schuster of the Forestry Relations Department, Tennessee Valley Authority. This parasite has become successfully established in the northeastern United States on the European spruce sawfly and is fairly abundant in certain areas. It apparently will attack practically all species of Diprion and Neodiprion sawflies. LeConte's sawfly cocoons are readily attacked under laboratory conditions and the adults produced are larger than average size.

Southern

The state law of Alabama for licensing pest-control operators appears to be the most inclusive and suitable for other southern states to copy, and has been recommended for the state law of Texas.

Officials of the Kisatchie National Forest near Alexandria, La., have tested additional fumigants for the control of the Texas leaf-cutting ant; record sheets for the treatments made in November and December have been prepared and the locations of the colonies tagged in the field and mapped.

December 17 was spent by Snyder at Abbeville and Kaplan, La., with J. H. Fahrenbach of the Internal Revenue Service, Washington, D. C., and H. G. Bates of the local office, inspecting a series of warehouses on which tax exemption claims had been made to cover damage to the buildings caused by termites; these claims were not warranted.

Johnston is continuing the tests of metal termite shields in a heated greenhouse at Saucier, Miss., and there is considerable activity by termites building tubes on but not over most of these shields.

Snyder attended a conference at Washington, D. C., on the correlation of this Bureau's work on termite-proofing buildings and the chemical control of powder-post beetles attacking stored wooden products with the Defense Program.

During January additional treated stakes for new preservative tests were shipped to Barro Colorado Island, Canal Zone, Panama and Saucier, Miss., for inclusion in our termite-resistant tests. These included stakes treated by both pressure impregnation and soaking methods with pentachlorophenol and combinations of this chemical, fuel oil, and coal-tar creosote.

PATHOLOGY

(In cooperation with the Bureau of Plant Industry)

Appalachian

Little-Leaf Disease. A progress report, giving the results of the first 5 months' work on this project by members of the staff at Athens, Georgia, Auburn, Alabama, and Asheville, North Carolina, was issued. A new map showing the known range of the disease as it occurs from central Virginia to northeastern Mississippi is presented. The report cites the poor condition of the roots of diseased trees, the indications of a possible correlation of little-leaf with soil conditions, and the apparent lack of correlation of the disease with weather.

Since issuing the progress report a description has been received of sickly and dying shortleaf pine in Cherokee County, Texas, that may prove to be little-leaf. Parts of longleaf pine stands in Escambia County, Alabama, are showing definite symptoms of little-leaf.

Farm Forestry Demonstration Plots. Four demonstration plots, of one acre each, showing methods of treating young sprout hardwood stands so that a minimum of decay would develop in the final stand, were established in Louisa County, Virginia, in cooperation with the farm forestry project of the Soil Conservation Service. This work was aimed at favoring seedlings and seedling sprouts, and removing surplus stump sprouts while the resulting wounds were still too small to transmit decay to remaining stems.

Northeastern

Rot in Fire-Scarred Hardwoods. An investigation of rot in fire-scarred hardwood trees was begun in western Connecticut in cooperation with the State Forester's office. The stand consisted of oaks, birches, maples, and the usual accompanying species in small numbers. A bad fire ran over the area between the growing seasons of 1921 and 1922. The surviving trees average nearly 50 years old, thus being rather small at the time of the fire. In most cases the fire scars were relatively large and have not completely closed. Data were taken on the original scars, the extent they have healed over, and the extent of the rot which entered through them. Samples were taken for cultural identification of the fungi causing the rots. Three hundred and seventy-five trees were dissected. Eleven species were represented by 30 or more individuals each and a few infrequent species by smaller numbers. The data will be analyzed for correlation of extent of rot with the relative size of the scars on the trees.

Southern

Dry Rot. An address on wood-decay in buildings was presented to the Third Southern Pest Control Conference at Louisiana State University on January 28, 1941. The address centered around an analysis of our records on cases of dry rot caused by Poria incrassata. The data show that in the 21 cases studied the chief contributing causes were (1) dirt-filled porches in 6 cases, (2) forms left in pouring concrete steps, etc., 2 cases, (3) untreated wood in contact with moist concrete floors, 7 cases, (4) joists, siding, etc., touching ground, 4 cases, and (5) refuse under the house, 2 cases. In most cases there were one or more other contributing causes, mainly inadequate ventilation of the subfloor area, excessive rain seepage into the interior of walls, and leaky plumbing. These data suggest the chief construction practices to be avoided in preventing dry rot infection or to be corrected in arresting dry rot already present in a building.

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Bentley, J. R.	Automatic recording of salting and watering habits of cattle. Submitted to Jour. For.
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Lake States

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Zon, Raphael	The cut-over region--breeding place of migrants. (For publication by Wis. State Council of United Brotherhood of the Carpenters and Joiners of America.)

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Reid, E. H., and Pickford, G. D.	A comparison of the ocular-estimate-by-plot and the stubble-height methods of determining percentage utilization of range grasses. (For Jour. of For.)

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Bruce, David. — The new longleaf-slash pine fire-danger meter. (For Dixie Ranger.)

Southwestern

Pearson, G. A., and Wadsworth, Frank H. — An example of timber management in the Southwest. (To Jour. of For.)

STATION NOTES

Central States

Crawmer, J. Richard, and Kellogg, L. F. — Local volume table for yellow poplar (Liricdendron tulipifera) in Holmes County, Ohio. (Tech. Note No. 24.)

_____ — Local volume table for eastern white pine (Pinus strobus) in Holmes County, Ohio. (Tech. Note No. 25.)

_____ — Local volume table for eastern hemlock (Tsuga canadensis) in Holmes County, Ohio. (Tech. Note No. 26.)

Diller, O. D., and Kellogg, L. F. — Local volume table for yellow poplar (Liriodendron tulipifera) in Hamilton County, Ohio. (Tech. Note No. 22.)

McLintock, Thomas F. — Effects of ground preparation on survival and growth of planted pine and black locust. (Tech. Note No. 23.)

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Lake States

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